POWER

Established 1884—McGraw-Hill Publishing Company, Inc.

ELY C. HUTCHINSON, *Editor*

VOLUME 74 DECEMBER 29, 1931 NUMBER 26

Fair Play

A manufacturer sold two units of several hundred horsepower, and special design, to a company whose name was important and rating A-1. The contract was subsequently changed to one unit at half the original contract price with an option on the second.

Some time after completion, the manufacturer, according to his custom, sent an inspector to see that everything was performing properly. This man found two units, exact duplicates, in operation where only one had been furnished.

Inquiry developed that the purchaser, with a genius worthy of a better cause, had prevailed upon a local iron works to make him a duplicate unit—copied by a draftsman and using some parts of the original for patterns.

The shop proprietor was told there were no patents and believed it. He subsequently turned all his patterns and drawings over to the legitimate manufacturer.

But the purchaser brazenly maintained that he saw no reason for paying the manufacturer's price for two units when he could get the engineering and experience of the builder in one machine and have someone else make the second at ordinary machine shop rates.

It is hard to believe that men still exist who have such little understanding and respect for the business rights of others. This and similar practices are dishonest and are in large measure the manufacturer's justification for patenting everything he builds and cagily defending his designs.

The spirit of fair play is gaining in business but in some respects it still has a long way to go.

EDITORIALS

Turbine Inspection

An excellent example of the performance of a marine turbine and a splendid proof of reliability is reported in the record of an eight-stage unit operating on one of New York's municipal ferries. The steam pressure is 275 lb. and the unit averaged 250 days in service each year for seven years before it was opened for inspection. That the machine should continue in regular operation for this period without inspection indicates careful operation, clean steam and good construction.

Excellent as this record is, such operating procedure can not be recommended. To run for seven years without inspection is surely courting disaster. Cracked buckets, broken lacing wire and badly erroded blades and nozzles may exist for some time without giving any outward indication to the operator. Should failure eventually occur, great damage may be done to the turbine, and with a marine unit the loss of propelling power may occur, to say the least, at a most inconvenient moment.

Defects such as these are regularly found during the annual inspection of turbines and remedied before failure may cause additional damage. Utility operators recognize pretty well that "A stitch in time saves nine," since the N.E.L.A. Prime Mover Committee reports that sixty-three per cent of the turbines in its group are subjected to annual inspection. The practice is worth extending to the limit.

Interstate Power Regulation

In recent years a number of power companies have grown from local institutions to interstate systems. This expansion has brought new rate and other regulation problems which need solution. In its recent report the Federal Power Commission emphasizes this condition and suggests that Federal authorities deal with the problem. President Hoover, in his message to Congress, has declared for effective regulation of interstate electrical power as an essential function of the reorganized Federal Power Commission and states that this is urgently needed for public protection. Such Federal Power Commission authority to regulate interstate power transmission is resented by some interests as an unwarranted Federal interference with state rights.

Few will question the desirability of having the states perform all functions of regulation if they would or could. They have not, however, shown a capacity for solving their joint problems by common procedure. Many instances may be cited where they have hopelessly disagreed in dealing with conditions less involved than rate regulation.

If the inability of some groups of states to deal successfully with their common problems is a sample of what may happen if interstate power regulation is left to them, then it is certain there will be no interstate regulation. Moreover, very few of the states have exhibited the initiative that would indicate their ability to get together in utility matters of joint interest.

Federal regulation, then, seems the only logical solution, and the Federal Power Commission appears to be the appropriate body to do the work. Notwithstanding that more federal government in business may be unwelcome, here is a case where, lacking some unexpected intrastate remedy, it seems inevitable. The best way out is evidently to face the facts and endeavor to have regulations established which will be acceptable to all interests.

Too Much Lubrication

The philosophy of being satisfied with no less than too much seems to be generally accepted by operators of diesel engines as applying to lubrication—to the detriment of engines.

The report of the Diesel Power Cost Committee of the A.S.M.E. shows a startling variation in the amount of lubrication used in the various reporting plants. Even with approximately the same capacity factor, the engine kilowatt output per gallon of lubricating oil varies as much as one thousand per cent.

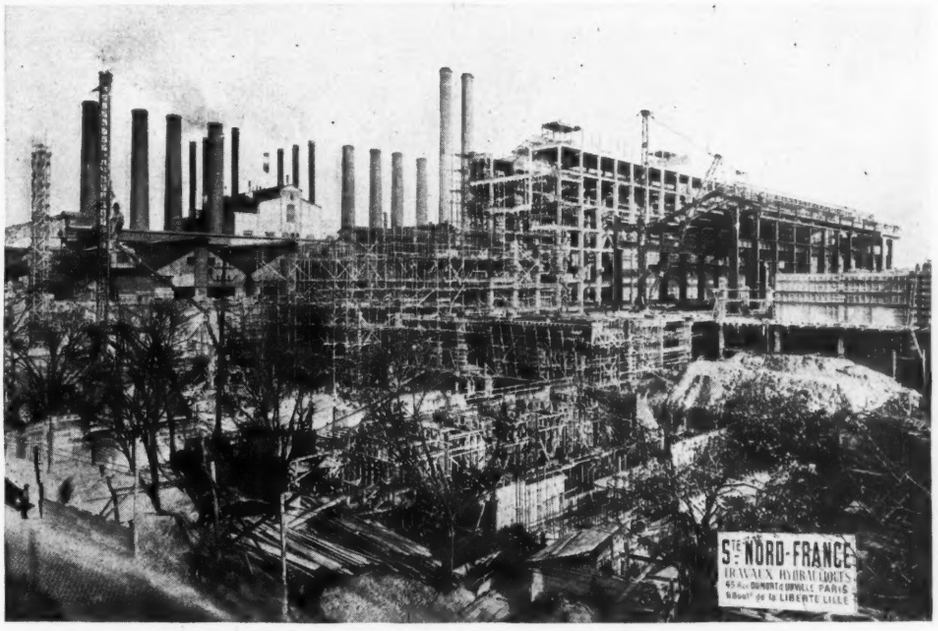
Of those plants having a low consumption no criticism can be made, but surely it would be to the advantage of those with a poor showing to investigate the cause of the rapid oil consumption. Not only does lubricating oil cost money—in some plants the annual amount being ten per cent of the fuel oil bill—but excessive oil fed to diesel cylinders causes carbon formations, gummed piston rings and irregular operation.

Basically, excessive lubrication is due to the operator's fear. Not being as well acquainted with the diesel as with the steam engine, he endeavors to safeguard the plant by increasing the oil feed. In other instances he continues the rate of feed necessary while the engine is being run in but unnecessary and excessive after the cylinders have been run in. Engineers will do well to reexamine their plant records and see if better operation cannot be obtained by a reduction in oil feed.

▼

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason



St. Denis station under construction. Old station in background

ST. DENIS

Heralds New Era in French Steam Practice

By R. H. ANDREWS
Consulting Engineer, Paris

French engineering practice has inclined toward holding steam pressures well below those current in the larger recent installations in Germany and the United States, while raising temperatures as high as properties of metals will allow. With the new St. Denis Station, however, designed for 925 lb. and 930 deg. F., a major step toward the practical application of high pressures to large electric stations has been made

IN THE historic old Parisian suburb of St. Denis, on the banks of the River Seine, a new high-pressure steam power station is being erected by the Société d'Electricité de Paris, which, with steam at 925 lb. pressure and 880 to 930 deg. F., marks a substantial advance in steam-cycle conditions over previous engineering practice in France.

In the past, French central station practice has shown considerable caution in following the lead of other countries in the movement toward higher steam pressures. In fact, to superficial observers who were ignorant of the intense research activity behind the scenes it has given the distinct impression of marking time until the advantages and disadvantages of high steam conditions had more clearly crystallized out of the operating experience of other countries.

This impression is supported by the steam conditions adopted for the latest large central stations, such as the extension to the station of the Compagnie Parisienne de Distribution d'Electricité, at Issy-lès-Moulineaux, and the new station of Union d'Electricité at Vitry-Sud, both of which remain in the conservative class using steam at pressures ranging from 450 to 600 pounds.

In view of the previous reluctance to raise steam pressures, the choice of such pressures and temperatures for the St. Denis station is unexpected. The pressure increase amounts to 50 per cent over the highest pressures ever used before in large French steam plants.

The explanation of this sudden jump, as also of the previous conservative progress, must be sought, in a very large measure, in the objection to steam reheating during expansion. In this connection it is interesting to note the essential difference between the reactions of American and European steam engineering to the cam-

paign started some ten or fifteen years ago for improving the efficiency of the steam cycle by raising the potential of Carnot's "hot body."

In the United States, in raising the potential of the live steam, the independent variable has generally been the pressure, which is chosen as high as economic and structural limitations allow, while the temperature has been maintained within conservative limits sanctioned by years of practical operation. Under these circumstances reheating of the steam during expansion was unavoidable to prevent excessive moisture of the steam in the lower stages of the turbine.

In Europe, on the contrary, the tendency has been, in the majority of installations, to make the steam temperature the independent variable, choosing it as high as consistent with the mechanical properties of existing piping, valve and turbine materials, while the pressure is chosen as high as possible, without necessitating reheating.

Therefore the true explanation of the persistance of the use of moderate steam pressures in Europe lies in the refusal of the majority of European power experts to accept reheating as a practical and economical means of improving the steam cycle, owing to the high cost of installation, and the complications in station design which it involves. With the exception of a few central European plants, which show distinctly the influence of American practice, the Loeffler and the Benson critical-pressure plants, in which reheating at least once is indispensable, this expedient has been almost universally rejected in favor of lower steam pressures and higher initial temperatures.

It is significant that, if we set aside the pioneer American installation of the Detroit Edison Company, which is designed for a temperature of 1,000 deg. F., instead of lagging behind American practice, France has been in the lead for the last five years or more in the matter of steam temperatures. Vitry-Sud operates at 790 deg. F., Issy-lès-Moulineaux at 840 deg. F., and St. Denis will generate at 880 to 930 deg. F. Furthermore, in the research field extensive work is under way with steam at 1,400 lb. and a temperature of 1,100 deg. F. Under these conditions, the superheater, the steam piping and the valves, are all well above red heat. Of course it is by no means certain that such temperatures will prove applicable in industry.

Few of the details of this station are available for publication at the present time; but the main lines of the design are as follows:

The ultimate capacity of the station will be about 400,000 kw. in seven units. At the present time three 50,000-kw. units are being installed.

Each generating unit will be served by two boilers, of 9,800 square feet of heating surface. It is interesting in this connection to note the progress in France toward the concentration of steam generation into large units. The 1926 extension of the Gennevilliers station, the new plant of the same company at Vitry-Sud, and the St. Denis station, all have 50,000-kw. generating units. But the Gennevilliers extension has four boilers per unit, Vitry-Sud three, and St. Denis two.

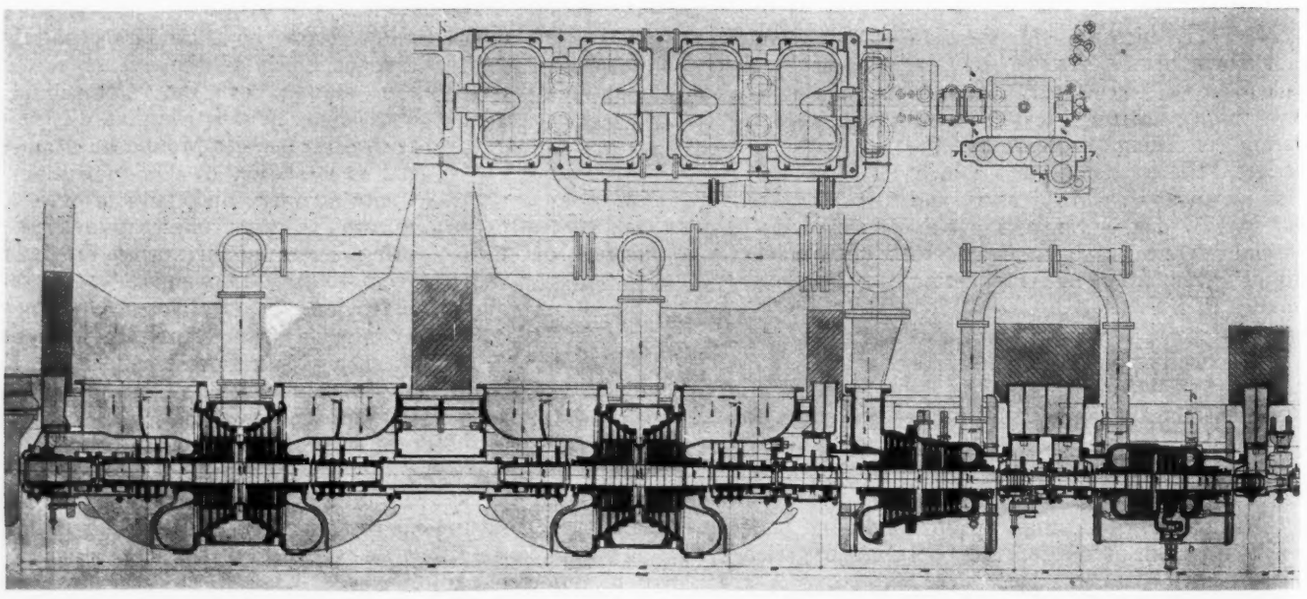
This point is important in its bearing on the system of firing adopted in the latter plant. Pulverized coal has been chosen, as in most of the latest Paris stations, not so much because of economy as of the facility with which this firing method adapts itself to fuels of widely variable composition.

St. Denis is the first large Paris station to adopt direct firing. Each boiler will be fired by four Attritor unit mills, feeding Calumet-type burners. The concentration of steam production into large units is unquestionably quite favorable to direct firing. This makes it possible to use several mills for each boiler. In this way one of the most serious defects of the unit mill, that is, the difficulty of maintaining the fineness within acceptable limits on variable loads, may be materially attenuated, since the load range of the boiler may be covered without operating the individual mills too far from their most favorable load points.

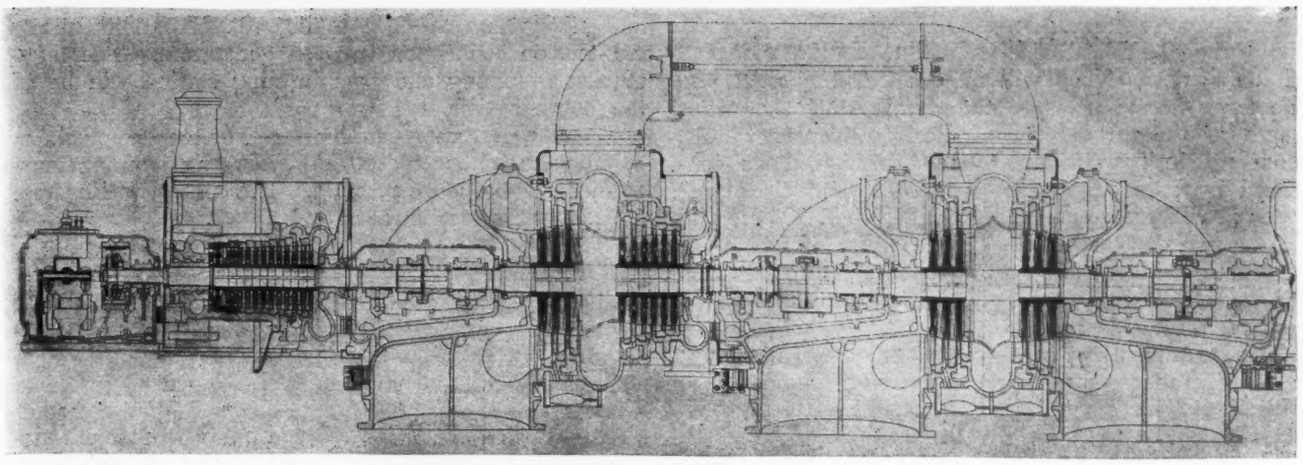
The mills of this plant will be completely isolated in a special building separated from the boiler house by an open court.

Water-Cooled Combustion Chambers

As shown on page 924 the combustion chambers will be water-cooled throughout, by means of tubular walls



Oerlikon steam turbine for 800 pounds pressure and 845 deg. F.



Alsthom steam turbine. Units are all single shaft and will generate 50,000 kw. operating at 3,000 r.p.m.

covered with Bailey blocks. The standard B. & W. V-shaped furnace bottom, lined with Bailey blocks, will also be used.

The boilers proper are of the standard B. & W. cross-drum type. As mentioned above, the boiler-heating surface will be 9,800 sq.ft. Each unit will also include a 4,030-sq.ft. interdeck superheater, a 10,700-sq.ft. steaming economizer, and a 56,000-sq.ft. tubular air preheater. The superheater surface is thus 41 per cent, the economizer 109 per cent and the preheater 570 per cent of the boiler heating surface.

The boilers will be arranged in a row, with a single firing aisle. Each boiler will be equipped with Prat suction draft, with an individual stack. There will be two forced- and two induced-draft fans per boiler, driven by three-phase, 3,000-volt variable-speed commutator motors, which will give a speed range of three to one.

Generating Units

The three 50,000-kw. turbine units now on order are thought to be the largest ever built for a speed of 3,000 r.p.m. Like the 50,000-kw. units at Gennevilliers and Vitry-Sud, the St. Denis units are tandem-compound, in three pressure steps. Their high speed, by reducing the allowable rotor diameters, raised new design problems, and particularly that of securing sufficient cross-section for the steam flow in the exhaust stages.

This is especially interesting because the question has been solved in three different ways by the manufacturers of the three different units installed. The more complex solution is that of Oerlikon, whose unit is shown in the cross-section. It consists of a high-pressure and an intermediate-pressure cylinder, in series, exhausting in parallel into two double-flow, low-pressure cylinders. This gives four low-pressure elements working in parallel, and exhausting into four condensers. If the speed had been 1,500 r.p.m. instead of 3,000, one double-flow low-pressure cylinder would have been sufficient. All the pressure steps are of the impulse type, and the steam flow in the high-pressure and intermediate-pressure cylinders is from the steam end toward the electrical end.

Brown Boveri's solution comprises a high-pressure and an intermediate-pressure cylinder step, acting in series, and exhausting in parallel into two low-pressure cylinders, one single-flow and one double. This gives three low-pressure elements acting in parallel and exhausting into three condensers. The high-pressure and intermediate-pressure elements are of the reaction type, with opposite steam flow, the admission being between the two; the three low-pressure elements are impulse turbines.

The Alsthom[1] turbine, shown above, is ingenious in that it saves one cylinder. This unit is closely similar to that of Brown Boveri, with the exception that the single-flow low-pressure element has been placed in the same casing as the intermediate-pressure element. The unit comprises, in series with the high-pressure cylinder, a combined intermediate- and low-pressure cylinder consisting of an intermediate-pressure element taking the full flow of steam from the high-pressure element, and a low-pressure element taking only one-third of the steam, while two thirds of the steam is bled between the intermediate-pressure and low-pressure elements and led into a double-flow low-pressure cylinder. Like the Brown-Boveri unit, the last has three low-pressure elements working in parallel and exhausting into three condensers. All the elements are of the impulse type, with the exception of a small Curtiss compound-velocity element at the high-pressure admission. The steam flow in the high-pressure cylinder is from the steam toward the electric end, and the reverse through the combined intermediate-pressure and low-pressure cylinder.

Owing to the length of the generating units, it was found economical to install them parallel to the center line of the boiler house. This arrangement has the double advantage of reducing the necessary width of the turbine room and of greatly simplifying the bleeder connections to the turbine. All the boiler feed and condensate pumps, together with the bleeder feed-water heaters and the evaporators, have been collected in a pump room between the boiler plant and the turbine room; and the bleeder steam connections between the turbine and the feed-water heaters or the evaporators are extremely simple. Furthermore, the turbine room basement is kept free of auxiliaries.

Condenser Layout

The Alsthom and Brown-Boveri units will each be equipped with three 10,100-sq.ft. surface condensers, and the Oerlikon unit with four 7,530-sq.ft. condensers, giving about 0.6 sq.ft. of condensing surface per kilowatt.

An unusual feature of the station will be the circulating-water system. Instead of equipping each generating

[1]Merger of Société Alsacienne de Constructions Mécaniques and Société Française Thomson Houston.

unit with a separate set of circulating pumps, all the pumps will be installed in a pump room at one end of the station. They will all deliver in parallel into two large intake pressure tunnels, running the whole length of the turbine room. Each condenser will be connected to both intake tunnels through ducts controlled by gate valves, so as to draw its circulating water at will from one supply or the other. There will also be two discharge tunnels, into either of which the condensers will discharge through valve-controlled ducts and weir chambers, which will insure a constant syphon head on the condenser.

This arrangement will give considerable flexibility in the operation of the circulating-water pumps.

Electrical energy will be generated at 10,500 volts, and stepped up at once to 60,000 volts, without any low-tension connection between generators. The high-tension switching and transforming station will be of the outdoor type.

The large station auxiliaries will be supplied, at 3,000 volts, either by 60,000/3,000-volt station transformers, or by house turbines. The control will operate on 220-volt direct current.

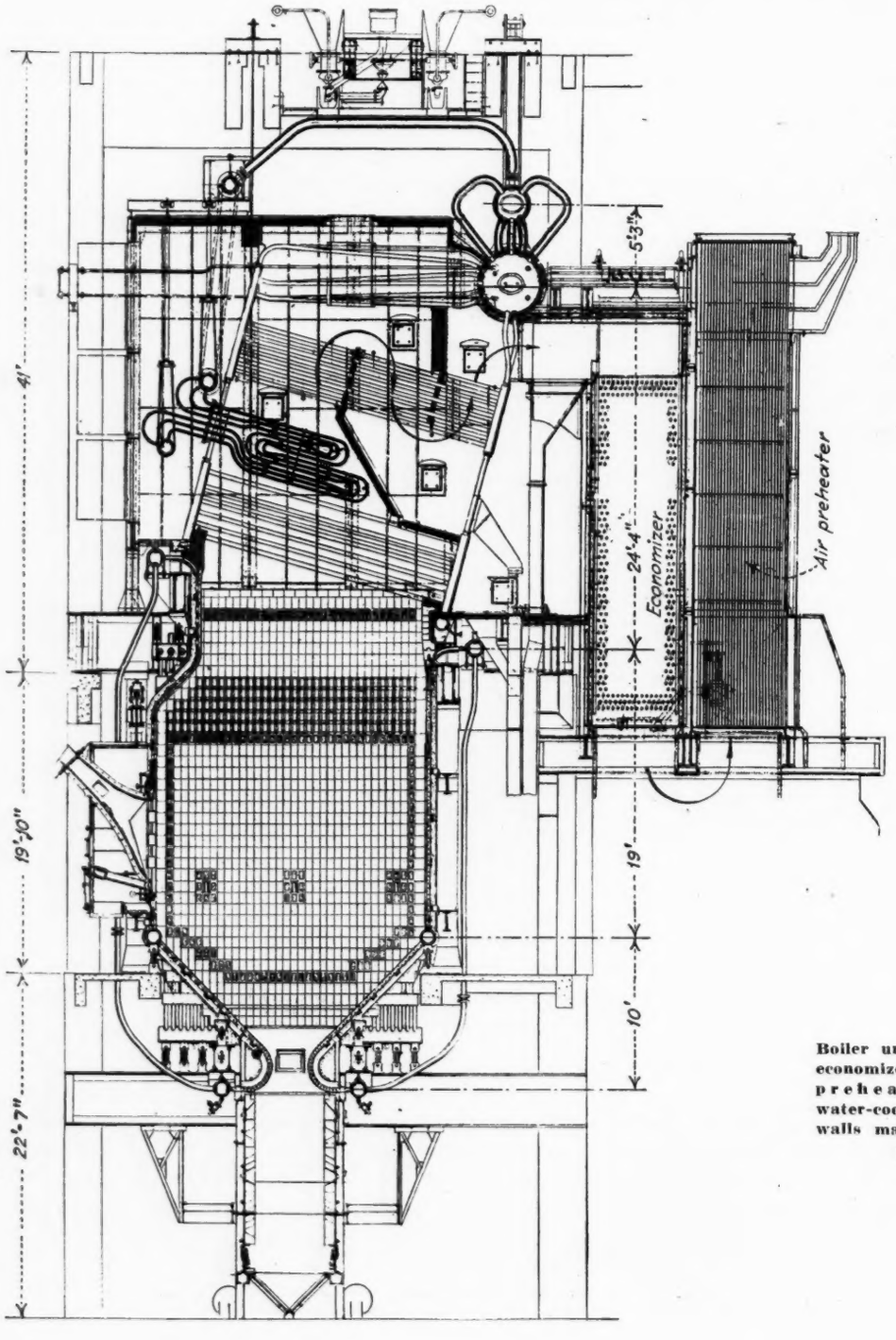
Dust Prevention

The St. Denis station will operate in the immediate vicinity of a densely populated manufacturing district, and dust prevention is extremely important.

The Modave flue-gas washing system will be installed. These washers, which have been installed in all the other large pulverized-coal stations around Paris, consist of a number of vertical cast-iron elements, in staggered formation, over the outer surface of which flows a film of water. The flue gas circulates between these elements, the solid particles separate out by inertia and are washed away as soon as they come in contact with the water film on the surface of the elements.

This system is claimed to separate close to 90 per cent of the solid particles carried by the gas.

The writer wishes to express his appreciation of the assistance and cooperation of Mr. Nicolini, director-general of the Société d'Electricité de Paris, in the preparation of this article. It is hoped that further descriptive information and operating data will be available after the station has been completed and put in service.



Boiler unit includes both economizer and large air preheater. Completely water-cooled furnace walls make high ratings possible

Boiler Gage Glass Readings Are Misleading

By GRANT CAMPBELL
Atlas Valve Company
Newark, N. J.

THE ADVANTAGES in economy of operation and upkeep and in reduced outage of boilers to be obtained by minimizing the carryover of solids are now well understood by power plant engineers, as is also the relation between the carryover and the water level in the drum. The usual plan is to hold the level in the glass at a point where the level in the drum will be as nearly as possible at the greatest disengaging surface. This will generally be at or about the center line of the drum. It is obvious that under present conditions the boiler manufacturer and the operating engineer must estimate from the observable level in the glass what the true level in the drum is.

The problem is not so much determining a level difference between the glass and the drum as it is regulating

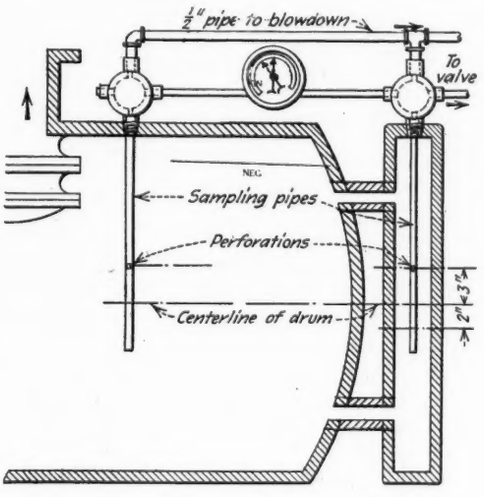


Fig. 1—Arrangement of instruments to show difference in level

the water fed to the boiler in such a way that the carryover will be kept at a reasonably low quantity under all conditions of operation.

The disengaging surface itself cannot under normal operating conditions or at high loads be a plane surface, because it will be affected by natural circulation, by irregular circulation due to water walls, by irregular circulation caused by varying intensity of furnace heat at different parts of the setting and by the rate of evaporation of the boiler.

Regulation, then, should be aimed at a limited area directly under the dry pipe, or the outlet nozzle of the boiler drum. At present the common method of observing the water level in the drum is by means of a tubular gage glass, or equivalent, generally attached to the water column, which must necessarily be outside of the boiler and the level in which may not even closely indicate the condition of the water surface at the point from which the moisture and solids are carried over.

By following British practice and placing the gage glass fittings directly on the drum the condition would be improved, but it would be still further improved if we were to eliminate the separate gage glass and modify the water column by the insertion of one or more plates of glass so that the level could be observed in the column itself.

This would still leave the error due to the temperature of the water in the column, which will be lower than that in the drum, and the difference in the temperature, and consequently in the level, will vary with the boiler-room temperature and with air currents. These differences also will be greater with the higher steam pressures.

It is proposed that the water column, modified for direct level observation, be closely connected to the drum with a water connection of ample size so that circulation may be set up in the column by withdrawing water from it as part of a continuous blowdown system.

A brief study of boiler operation will convince the operating engineer that if the temperature of the water at the point of observation is the same as the temperature of the water in the boiler drum itself, the level in the column will more nearly approach the level in the drum and at the same time the effect of increase or decrease in steam bubbles or foam will not be reflected in the column to the same extent it would if the water in the column were appreciably colder.

Having, by using the modified water column, eliminated part of the error due to the difference between the observable level and that in some indefinite point in the

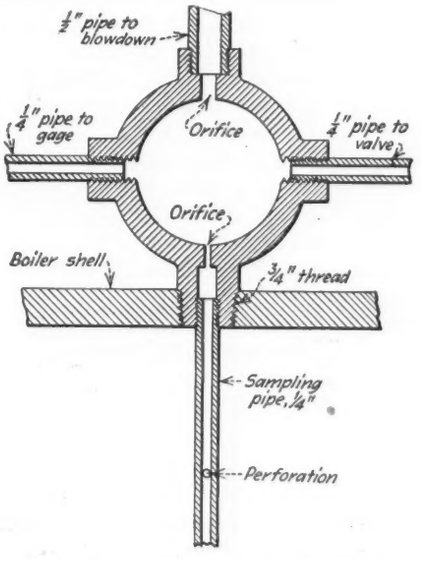


Fig. 2—Diagram of expansion element

boiler drum, we must still know what the level or condition of the water is directly under the dry pipe in reference to the observable level in the water column to obtain results that will be uniform for permissible carryover.

It is well known and understood that the actual difference between the level in the drum under the dry pipe and the observable level in the column will vary not only with types of boilers and with steaming rates, irregular circulation, concentration, and the point and

method of feed injection, but also with apparently identical boilers under exactly the same conditions.

What the operator needs to know, then, is not so much the physical level in the drum as it is the condition of the water surface and its tendency to cause priming. If it is possible under all operating conditions to know what the approximate relation of the observable water level in the column is to the actual level in the drum at or near the dry pipe we have gone a long way toward the ultimate solution.

If there are inserted in the water column and in the steam drum near the dry pipe instruments that can be calibrated to indicate or record the approximate levels at those points we shall have the desired result, namely, an indication or record of the difference in levels. Such an arrangement is shown in Fig. 1.

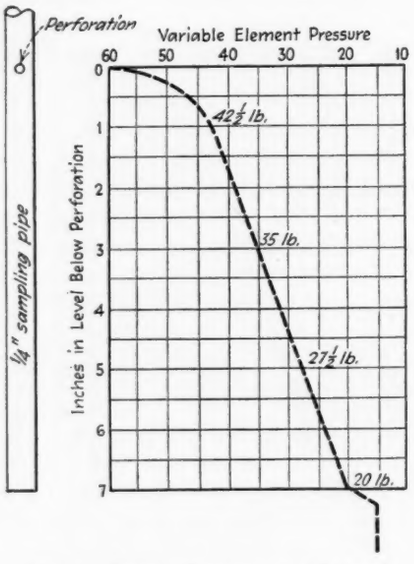


Fig. 3—Curve of pressure with level

The instrument consists of a combination of a perforated sampling pipe partly submerged, with an expansion element connected so that steam in a continuous stream is passed through the sampling pipe and expansion element to the atmosphere. The combination is shown in Fig. 2. The sampling pipe is designed to deliver to the expansion element a small amount of steam in which the moisture content varies with the water level in the vessel or water column.

The expansion element is fitted with calibrated inlet and outlet orifices which restrict the flow and are proportioned so that there is a reduced or intermediate pressure in the element. This reduced pressure varies directly in proportion to the moisture content in the steam rising through the sampling pipe and passing through the expansion element.

Fig. 3 shows the relation of regulating element pressure to water level that may be expected with a typical combination of element and sampling pipe. It will be seen that if suitably calibrated pressure gages are connected to the expansion elements between the orifices it will be possible to detect level differences and to approximate the amount of these differences. In practice a single gage will be used, having two tubes and two hands, one for each element, the difference in position of the two hands indicating directly the level difference at the two points. With a banked fire and practically no level difference the gage hands will stand nearly together, but with the boiler generating steam, as the rating increases the gage hand for the water column will fall behind the hand for the boiler drum because of the increasing level difference.

In service, with the two element combinations and the double gage, the method is to observe the action of the gage hand for the drum level and to so regulate the boiler feed that this level and its gage hand will remain within a limited range where no more than an allowable amount of moisture is carried over.

Fig. 4 shows an arrangement of gage dial that may be used with the combination described and with which the curve shown in Fig. 3 may be expected.

Referring to Fig. 1, the perforations in the sampling pipes are shown 3 in. above the center line of the boiler drum. If the water level is at the center line of the drum the gage hand will stand at about 35 lb. pressure. If, however, the level is 2 in. below the center line of the drum the gage hand will stand at about 27½ lb. pressure. It is true that with varying drum pressures the relation between level and pressure will vary to some extent, but in general the position of the gage hands can be relied on as a measure of level differences.

By utilizing as a motive power the pressure in either of the elements, preferably the water column element, and applying it to a pressure-responsive feed-water control valve the boiler feed can be regulated automatically for the desired level for allowable carryover.

With the instruments as described there will be a continuous outflow from the expansion chambers, which can be adjusted to be a small amount or to be an appreciable amount, as preferred, by proportioning the calibrated orifices. This outflow can serve not only as part of a continuous blowdown system, but also as a means of causing circulation in the column to hold the water in the column nearly to saturated steam temperature. This will tend to eliminate the error due to temperature differences, and since the concentration has a marked effect on the carryover by raising the level in the drum the proposed instrument will largely compensate for variable concentration.

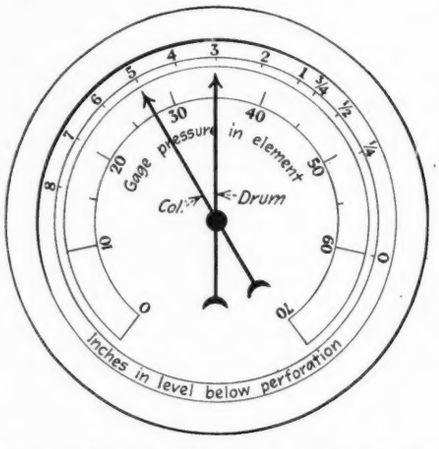


Fig. 4—Gage showing pressures and levels

Briefly, then, the cure proposed is a continuous indication or record of the approximate level difference and in addition a guidance under which to regulate the feed so that the carryover is kept within reason. It further provides feed water regulation combined with a continuous blowdown and the advantage of nearly saturated steam temperature in the water in the column.

As the method of feeding can have a material effect

on level and smooth operation, it seems probable that in high-pressure central stations a reliable system of feeding will eventually include an element of regulation providing for a variable pressure drop through the feed-water control valve in accordance with the output of the boiler. This combination or system results in regulation of input with output under guidance of a level regulation factor which corrects for errors in adjustment of pressure drop and provides positive limits in actual water level.

A recent installation of this type of water level regulation is at the Deepwater power station, where a number of the instruments described regulate the water level in evaporator hotwells. Another application is at the power station of the Consolidated Gas, Electric Light & Power Company, of Baltimore, Md., where the instruments are used to drain the condensate from high-pressure heat exchangers acting as air preheaters.

It has been found that by using various combinations of the calibrated orifices in the expansion chamber with variously treated sampling pipes and suitably ported control valves, level regulation in steam pressure vessels can be effected for input or discharge of either the water or the steam over wide or narrow limits in level change, as may be desired.

[This contribution by Mr. Campbell was prompted by the comments of Edwin H. Kreig in the July 14 number on the same subject.—Editor.]

▼ ▼ ▼

Benson Steam Generator At Langerbrugge*

THE Belgian power plant at Langerbrugge, near Ghent, owned by the "Centrales Electriques des Flanders et du Brabant," by its recent extensions has been made one of the most up-to-date power stations in the world.

The plant, started in 1914 with two condensing turbines of 2,000 kw. each, was destroyed during the war and re-erected and equipped in 1919 with two boilers for a steam pressure of 282 pounds.

Since 1925 the steam pressure has been continuously raised. The original high-pressure plant contained three Babcock & Wilcox boilers having a capacity of 26,500 lb. steam per hour each, at the pressure of 710 lb. and a temperature of 850 deg. F. There was a back-pressure turbine of 1,650 kw. and a condensing turbine of 6,600.

After good experience with high pressure, the whole plant was rebuilt in 1928 for the use of high-pressure steam. Three new Babcock & Wilcox boilers of 100,000 lb. of steam per hour each, at 800 lb. and 850 deg. F., and an additional 6,600-kw. back-pressure turbine were installed.

The Benson Steam Generator

Most interesting, however, is the Benson steam generator installed by Siemens-Schuckertwerke, A.G., which was placed in service in 1930. This operates at a pressure of 3,200 lb. and at the critical temperature of 706 deg. F., whereby water is converted into steam without boiling.

In outside appearance of the Benson steam generator resembles, as the Berlin plant, a tall tower with a short stack on top. The height of the actual boiler is approximately 100 ft., and it requires a floor space of 49x40 ft. Total height, including the stack, is 145 feet.

Square in cross-section, the combustion chamber of the steam generator is surrounded by tubes. Eight burners are arranged at the arch covering the chamber. These burn semi-coke, which is supplied from a low-temperature carbonization plant. Two burners are equipped for gas, while two additional burners burn fuel oil, which also is obtained from the low-temperature carbonization plant. Consequently gas, oil or pulverized coal can be used as fuel.

Feed water is heated to 356 deg. F. in an economizer with 940 sq.ft. of heating surface, which is arranged in the upper part of the boiler. It is then pumped by the main boiler-feed pump to a pressure of 3,550 lb. The water is forced through a battery of heating tubes arranged in the lower part of the combustion chamber, consisting of four parallel groups of 24 coils each. The internal diameter of the tubes is 0.8 in., the wall thickness 0.256 in. and the effective heating surface 5,400 sq.ft. In this first part of the boiler, the temperature of the feed water is gradually raised to 706 deg. F., at which temperature the water is converted into steam.

The steam is further superheated up to 850 deg. F. in a superheater of 6,800 sq.ft. heating surface. Combustion air is preheated to 752 deg. F. in four Ljungström air preheaters of 2,300 sq.ft. heating surface.

The capacity of the steam generator is normally 225,000 lb. of steam per hour; the maximum rating is 276,000 lb., but this can be raised to 300,000 lb. for one-half hour. The thermal efficiency is 87 per cent.

A high-pressure turbine of 4,000 kw. is directly supplied from the superheater, the admission pressure being 2,840 lb. per square inch; the exhaust goes back to the boiler at approximately 850 lb. and 617 deg. F. The reheater consists of 24-tube groups of 4 coils each. Steam enters a 25,000-kw. condensing turbine at 710 lb. pressure and 850 deg. F.

Steam piping between boiler and turbines is dimensioned for a pressure of 4,400 lb. and 850 deg. F. These tubes are made of special steel of a tensile strength of 71,000 to 100,000 lb. The external diameter is 7½ in. and the wall thickness 0.865 inch.

Good Example of Efficient Cooperation

Extensive industrial plants adjacent to the power plant, 31 different plants in all, directly consume the power generated. These plants give a load factor of 45 per cent. They include the plants for low-temperture carbonization according to the Salermo and Thyssen-Roser system, which deliver semi-coke, oil and gas directly to the power station. A refinery which takes care of all the low-temperature tar and produces, together with raw oil, fuel oil for motors and other products, is also a feature.

Because of the accumulation of various industries and efficient cooperation with these industries, the Langerbrugge high-pressure steam plant is an ideal example of generating and consuming electricity.

*Published in the Oct. 15 number of *Feuerungstechnik*, this article describes a 3,200-lb. steam generator with a normal capacity of 200,000 lb. per hour.

The sixth of a series of articles covering applications of the diesel as a source of power

The Diesel Locomotive Solves Railroad Problems

By OLIVER F. ALLEN
Consulting Engineer
New York City

Of all the avenues by which the railroads may overcome the discrepancy between expenses and income the adoption of the diesel locomotive appears to offer the greatest inducements. Oil engine locomotives, while still few in number have proved their efficiency and adaptability in varied fields of application, from switching service to high-speed main-line passenger service

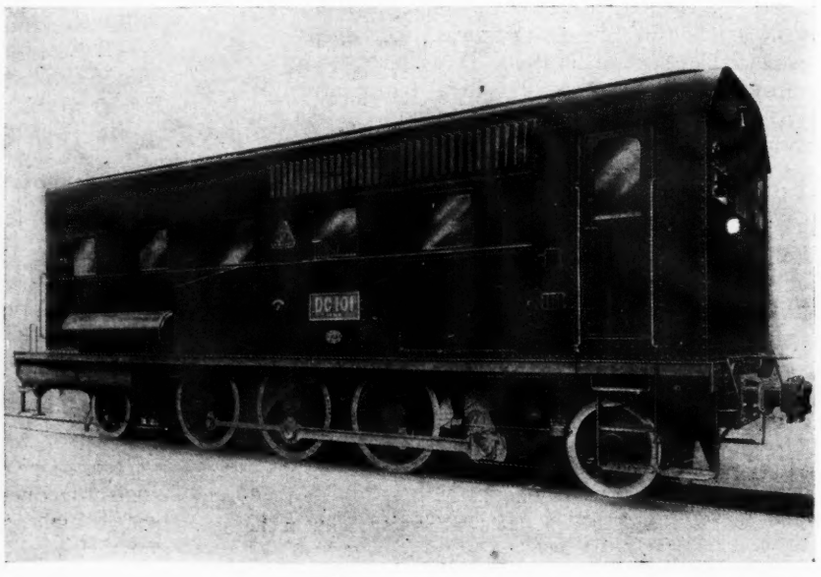
THE Diesel locomotive is a comparatively recent development and may be looked upon as having the railcar as its progenitor. By 1915 there were probably more than 200 railcars in regular passenger service on established railroad lines in the United States and Europe. Diesel engines with electric drive were in use in Sweden as early as 1913 and a few other European railcars had diesel motors in them, with both electric and mechanical drive.

Some of these railcars really functioned as locomotives, and there were also a few machines that could more properly be described as locomotives; so it is proper to say that rail transportation with both locomotives and railcars using internal-combustion engines was established commercially prior to 1915.

Projects for large diesel locomotives, that is, machines of about 1,000 hp., were restricted to mechanical drive, with compressed air as auxiliary power for starting and reversing. One of the practical results was a locomotive of about 1,200 hp. built in Switzerland with a four-cylinder "V" diesel engine mounted transversely upon the chassis and connected to the driving axles through siderods. Compressed air was provided for starting. This locomotive was ahead of its time, and lack of experience regarding the speed-torque characteristics inherent in the diesel motor and the speed-tractive-effort requirements of railroad service doomed it to early failure.

During this same period considerable advance was made in the manufacture of air compressors, and a natural result was the attempt to develop a successful compressed-air drive for diesel traction. This, however, never resulted in a machine of general commercial applicability. The most serious recent development of this sort was a compressed-air transmission locomotive built in 1928 for the German State Railways. This engine, designed to develop 1,200 hp., is still in experimental service, but

Fig. 1—Krupp diesel locomotive with mechanical drive



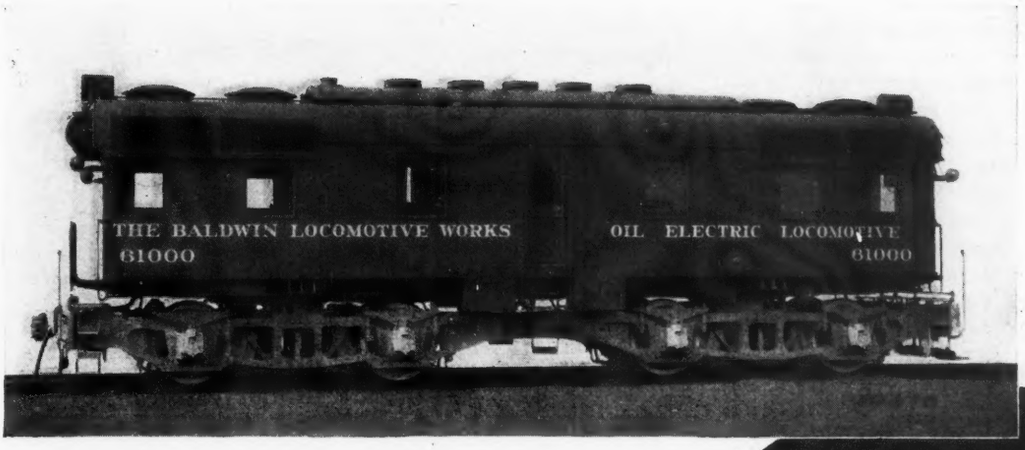


Fig. 2 — Baldwin locomotive with a Krupp diesel and electric drive

present indications are that it will not be duplicated.

On the other hand, the use of compressed air for starting oil engines has become general for all classes of service. It is being applied for most rail installations except those employing a battery for lighting and other auxiliary services, which is utilized for starting the engine the same as on an ordinary automobile. This type of starting is now being applied to some large locomotive units.

In the larger mechanical-drive machines air is frequently employed, both with and without electric control, for actuating gear shifts and clutches, while in electric-drive equipment air sometimes furnishes the power for operating the electric control gear.

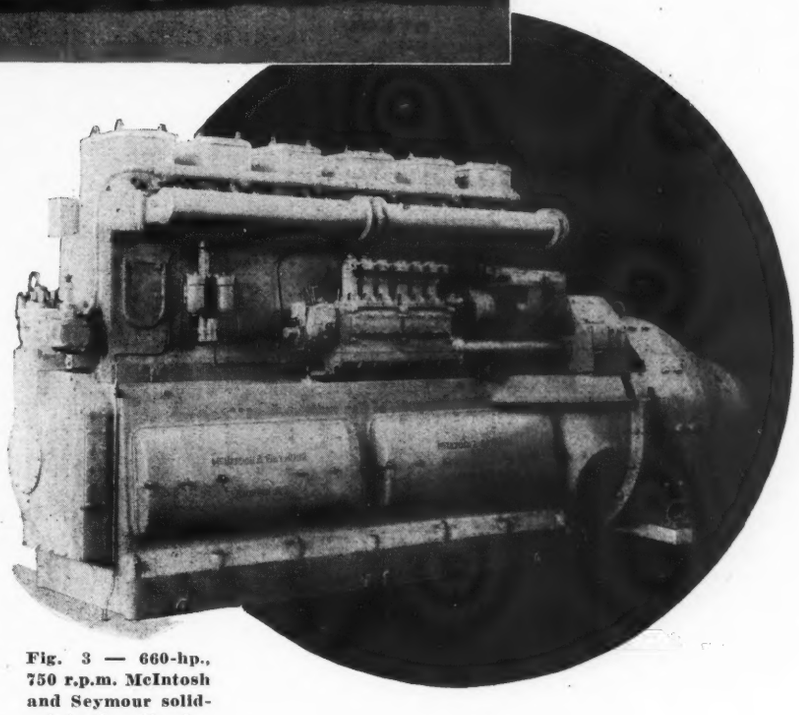


Fig. 3 — 660-hp., 750 r.p.m. McIntosh and Seymour solid-injection diesel

Another development which has some engineering interest, but has not yet become commercial anywhere, is various combinations of diesel and steam engines on a single chassis with and without compressed-air auxiliaries, the designer seeking to combine the advantages of both types in an improved heat cycle. The English Kitson-Still locomotive is perhaps the best example.

From 1915 to 1919 the use of internal-combustion engines for rail service was studied intensively in the United States, France and England by the military authorities, and these studies and the application of larger gasoline engines than had been used previously for traction, particularly on narrow-gage locomotives and tanks, prepared the way for the more intensive study of these problems during the past dozen years. Similar conditions in Germany produced improved diesel submarine motors which were available immediately after the armistice for the first practical diesel locomotives of large capacity.

During the five years from 1919 to 1924 the military and naval experience and studies just referred to were translated into commercial terms, and in 1924 the first diesel-electric switching locomotives of a really commercial type were put in service in the United States at about the same time that both electric-drive and mechanical-drive diesels with modified German submarine engines were sent to Russia. The American locomotives of this period, 1924 to 1929, were, with one or two exceptions, 300-hp., 60-ton units for standard-gage railroads and a variety of smaller units for the narrow-gage and industrial services. The Russian units had a continuous rating of 800 hp. and were designed for long main-line hauls, while the American machines were restricted to yard work.

Due perhaps chiefly to difference in fuel costs and the Russian demand for long-distance operation, more attention was given to the development of the large main-line locomotive in Europe than in the United States, where, due to higher labor costs, more attention was paid to the switching locomotive. The result of this was that by 1930 there were more than 100 diesel locomotives in switching service on standard-gage tracks in the United States, all electric drive. With very few exceptions, these are equipped with 300-hp. multi-cylinder diesel motors, the majority having one engine for a locomotive, but a number are equipped with two engines per locomotive.

There are also about half a dozen locomotives, also electric drive, of between 750 and 1,320 hp., in service in the United States and Canada, but each of these is the first or second unit of a new type, and consequently only the 300- to 600-hp. units can be considered as commercially standard, both as to production and railroad utilization.

These larger machines, with single engines of 750, 880, 1,000 and 1,320 hp., have been so successful that at least

three of the types are being duplicated and another type of 1,000 hp. is being built here.

Adding the small diesel locomotives for narrow-gage and industrial service, employing Winton, Buda and other high-speed engines, the total of diesel locomotives now in service in the United States may be taken as about 125. There are a few in Canada and about a dozen have been exported from the United States.

Electric drive, which has been universally employed in the United States for the standard-gage locomotives, has been received more slowly in Europe. Up to two or three years ago the European engineers, in general, favored mechanical drive for all sizes, and, in addition to one of the large Russian locomotives already referred to, made other experimental units of 1,000 to 1,200 hp. with mechanical drive. These have not been entirely satisfactory. While progress is being made with mechanical drive, it is admitted generally in Europe today that electric drive is the only practicable coupling for locomotives of over 300 or 400 horsepower.

There are examples of mechanical drives up to 300 or 400 hp. that are commercially successful, such as those on the railcars of the Hungarian State Railways, whose power plants have been supplied by Ganz and Company of Budapest, and on the geared locomotives supplied the Japanese State Railways by Fried Krupp. For industrial service and general switching service, in Europe, small mechanical-drive diesel locomotives have proved to be satisfactory. The Humboldt works at Cologne, for instance, even in these hard times is turning out one of these locomotives per working day, the size varying from 15 to 100 horsepower.

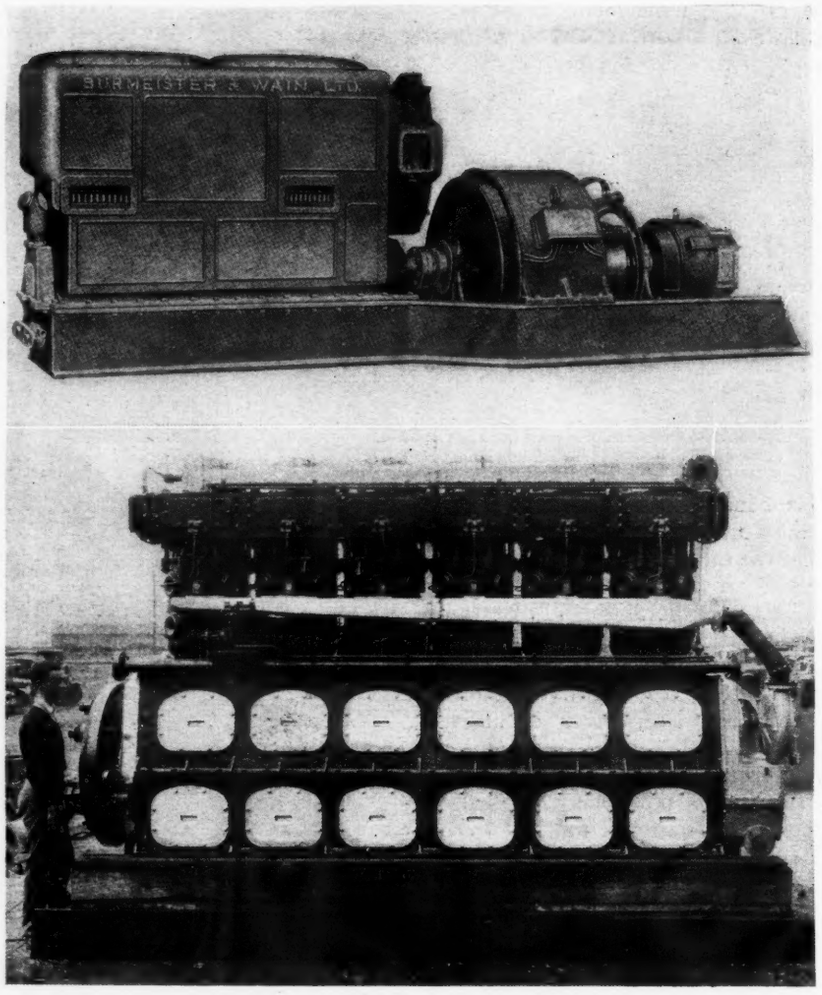


Fig. 4 (Above) — Burmeister and Wain double-acting diesel for locomotive service. Fig. 5 (Below)—800-hp. Ingersoll-Rand diesel designed for locomotive application

Substantial orders are being executed on the Continent and in England for diesel locomotives of moderate size, that is, from 200 hp. to 1,000 hp., but the majority within this power range are being built with electric drive. As these orders are scattered over about a dozen countries, they may be taken as typical of the present trend, and it may be stated that electric drive is almost universally indicated for units over 200 horsepower.

The early gasoline railcar engines weighed about 50 to 60 lb. per horsepower, and most of the 100 oil-electric locomotive engines referred to as now in yard service in this country have about the same weight and run at about the same speed. The gasoline railcar engine has been refined, along with other automotive gasoline engines, until it now weighs only about 15 to 20 lb. per horsepower and runs at from 1,000 to 1,800 r.p.m. The diesel is following the same trend. The American engines of new types and sizes weigh from 30 to 40 lb. per brake horsepower, continuous rating, and the European engines, 1931 vintage, are down to 17 to 20 lb., at from 900 to 1,300 r.p.m., for the same ratings. In other words, today's diesels weigh no more and take no more space than the gasoline motors used for rail service. Besides, the gasoline engines are practically limited to 600 brake horsepower or less per unit, while locomotive diesels of 1,600 b.hp. are now being built.

The weight and rotative speed of the engine has a very direct bearing on the weight of the locomotive. The 50 or 60 lb. per horsepower diesel at 600 r.p.m. has meant that the horsepower per ton of locomotive has been only five, that is, 300 hp. for 60 tons, while for the steam locomotive and the contact-type electric locomotive it has been from 10 to 15 hp. per ton. In switching service, where the speeds are low and the tractive-effort high, this weight is not objectionable, but, in fact, is essential in order to get sufficient adhesion. On the other hand, as soon as the locomotive goes out of the yard onto the line and begins to speed up to haul a train at the rate required by present-day railway practice it must have more horsepower per ton. Even with the comparatively heavy engines used in the United States, there has been an improvement, partly due to larger units, partly resulting from higher rotative speeds of the generating units and somewhat to other refinements. For instance, the 600-hp. locomotives referred to deliver 6 hp. per ton, and some narrow-gage 250-hp. machines have reached 8 hp. per ton. A 1,000-hp. unit now building in the United States will have between 9 and 10 hp. per ton.

European practice has gone a little farther than American, and locomotives from 300 to about 600 or 800 hp. are already up to 10 hp. per ton, while the larger locomotives now under construction of from 1,000 to 1,600 hp. will have from 11 to 14 hp. continuous rating per ton.

The present limit seems to be a new machine for the Italian State Railways, 1,000 hp., 64,300 kg. total weight, equal to 15.65 hp. per ton.

Two special types, developed to meet local conditions, should be mentioned. The "combination" is a locomotive with a diesel engine and a large storage battery. Those built have been mostly with 300-hp. diesels and 300-kw.-hr. batteries. The weight is about the same as for a machine with two 300-hp. engines. There is more energy available for acceleration and less for regular haulage than with the locomotive with twice the engine capacity. The other type is the so-called "three-power," which is essentially the "combination" with the addition of contact shoes for third-rail or overhead-trolley supply when on the electrified portion of a system. This type is exemplified by nearly 50 machines on the New York Central's west side tracks in New York City. There are also some "combination" diesels using contact shoes, without the battery.

Up to a little over two years ago the diesel locomotive was not the competitor of the steam locomotive outside the industrial plant or the freight yard. It could not even do the work which the ordinary small steam locomotive does on branch lines and other light train services. That situation has now changed, and with diesel locomotives with an output of 10 to 15 hp. per ton the railroads can haul trains the same as they do with the steam and contact-electric machines.

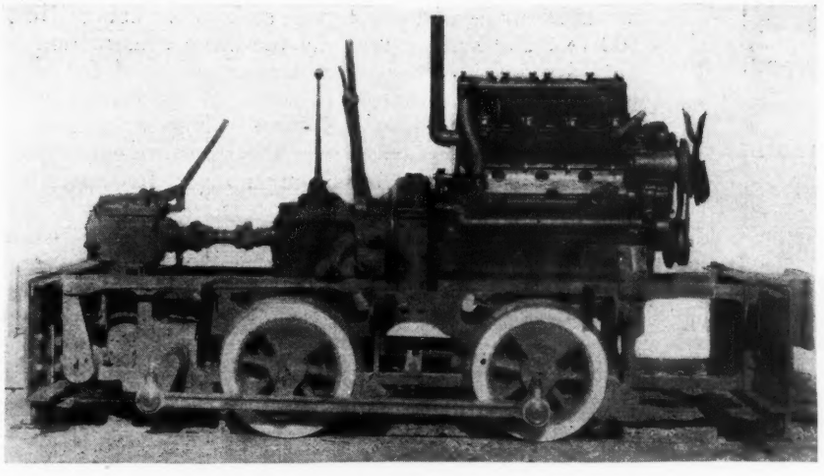


Fig. 7—Small mechanical drive locomotive powered by a Cummins diesel

The railroads seem to be satisfied as to the economic value of the diesel locomotive in yard service. Even in these times of reduced purchasing power substantial orders are being placed, as for instance, seven switchers each with one 325-hp., 550-r.p.m. Ingersoll-Rand diesel, now being delivered to the Bush Terminal, Brooklyn, N. Y., and five of about the same size going into service in the Lehigh Valley Railroad yards in Jersey City. This Lehigh Valley purchase illustrates the fact that there are already several makes of American engines available, for two have Winton engines, two have McIntosh & Seymour engines, and one has an Ingersoll-Rand engine. All of the units have electric drive.

The records of diesel locomotives in our railway yards during the past five or six years show: that the problem of servicing and maintenance has been solved; that ability to manipulate quickly and accurately, thereby facilitating spotting and train make-up, is greater than with steam; that the availability factor is far higher; and finally, that the over-all operating cost of the diesel-electric locomotive is from 30 to 40 per cent less than the operating cost of steam locomotive in the same service; the fixed chargers, however, are higher.

On the main line, and even on branch lines, the diesel is still an experiment. One may conclude, however, from the field experience in Russia and in the Argentine, confirmed by a Russian order for a single-engine, 1,600 hp. diesel locomotive and an Argentine order for four 1,800-hp. machines with two diesel engines each, and from engineering experience and studies in the United States, England, Switzerland, Germany, Italy, Austria, Denmark, Sweden, Japan and elsewhere, that the main line diesel locomotive of 3,000 or 4,000 hp. is technically practicable and the medium-sized machine of from 1,000 to 2,000 hp. is an accomplished fact. The diesel engine requires about one-tenth the weight of fuel of the present steam locomotive and almost no water. The steam locomotive requires about 7 lb. of water per pound of coal, consequently 100 lb. of fuel oil in a diesel locomotive tank replaces 8,000 lb. of coal and water in the steam locomotive tender. There would be many more revenue-miles per year per machine, and repairs and operating expenses per locomotive-mile would be greatly reduced if the diesel replaced the steam locomotive. With increased demand and less weight per horsepower the first cost of the diesel would be reduced and the indications are that even when compared with the most modern and refined, even if complicated, steam machines, the large diesel-electric locomotive will be able to prove its economic value out on the line, even as the smaller ones have in the yard, and show the railroad a handsome return on its purchase price.

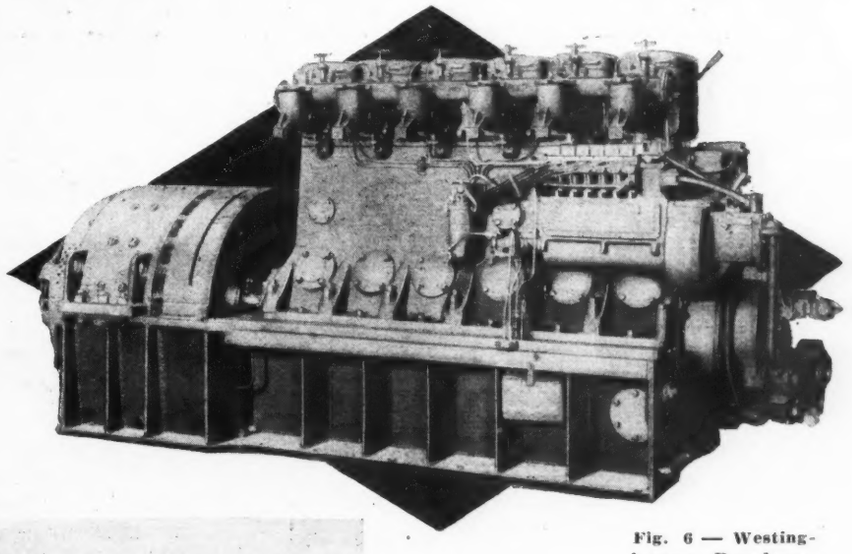


Fig. 6 — Westinghouse Beardmore locomotive diesel

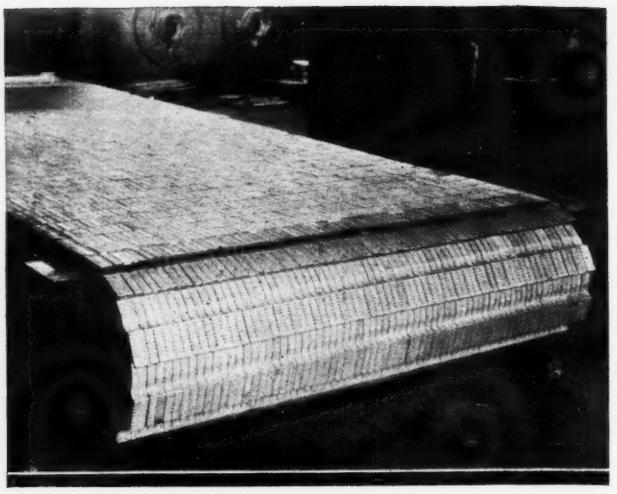


Fig. 1—Harrington traveling-grate stoker with new design of overlapping grate surface.

Design and Operating Features of Traveling- and

In this, the last of a series of three articles, natural- and forced-draft chain-grate, louver-type with pivoted grate bars and traveling-grate stokers are described. The previous articles, dealing with overfeed and underfeed types, appeared in the Dec. 15 and 22 numbers, respectively

AN INHERENT characteristic of the chain- and traveling-grate types of stokers are their ability to handle a wide range of fuels. They are generally recognized as the standard stoker for burning anthracite culm and other anthracite wastes, coke breeze or a mixture of these fuels with bituminous, and because they maintain, in operation, an undisturbed fuel bed and discharge the ash and refuse continuously they are particularly suitable for the high-ash, non-coking bituminous coal of the Middle West. Low-grade coals having as high as 35 per cent ash are being handled successfully.

Stokers of this type for forced-draft operation are now being built in widths up to 24 ft. and lengths of 22 ft. or more. Combustion rates, at the point of best efficiency, are around 30 to 35 lb. per hour per square foot of grate area, but rates as high as 60 to 65 lb. per hour can be obtained without difficulty.

The natural-draft chain-grate stoker had a wide field for many years, but with the increasing demand for higher capacities from a given size of boiler and furnace the trend is toward the use of forced-draft units. In many respects the two types are similar, the principal difference being the greater amount of air space provided in the natural-draft grate.

Because proper uniformity of air distribution is vital to the efficient performance of chain-grate stokers, some manufacturers provide a wide range of air regulation the full length of the grate in both the forced- and natural-draft types. In one of the more recent developments in small-sized chain-grate stokers for boilers from 500 to 2,500 sq.ft. essentially the same construction is used for both types, with a damper provided for each foot of length from front to rear. When installed for natural-draft operation the front riding seals, bottom seal plates and dust cover over the front are eliminated. In some installations provision is made for operation with either draft.

Various methods are employed to divide the air chamber into zones and seal the grate at the front and rear against air leakage. In the unit, Fig. 4, cross beams of H section protected by cast-iron caps at the top serve to partition the chamber. Steel plate seals hinged to the beams ride on the chain and prevent flow of air between the zones. In other units the air chamber sections directly below the grate are of triangular cross-section, with the controlling dampers forming one side of each section. In other stokers employing a similar design the controlling dampers are at the end and scraper chains are placed in the bottom of each compartment to remove the siftings. In the natural-draft units fitted with multiple-air control the dividing partitions extend only sufficient distance below the grate to permit the installation of a damper, as shown in Fig. 8.

Probably the outstanding characteristic of the present-day chain grate is the ease of maintaining smokeless combustion with high volatile coals. This is due not so much to the uniform feeding and undisturbed fuel bed as to the use of liberal arches which tend to maintain high temperatures and increase turbulence in the combustion gases to the point where stratification is practically eliminated.

In the original furnace designs for chain grates the front arch construction was used exclusively. Later designs used a combination of front and rear arch and

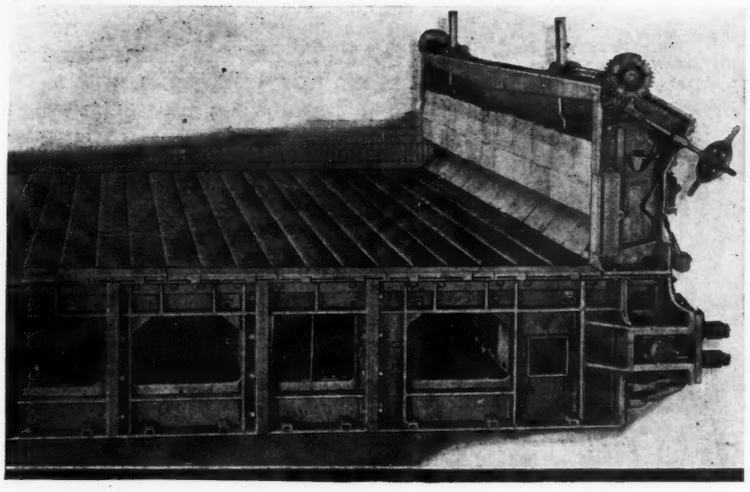
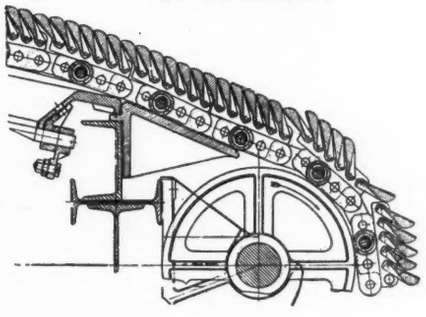


Fig. 2 — Coxe forced-draft traveling grate with zoned air control

Chain-Grate Stokers

more recent designs use the all-rear arch construction. Not only have these later designs greatly improved combustion, but arch maintenance has been reduced materially in the larger units through the use of water cooling.

Fig. 3—C-E louver-type traveling grate



A combined front and rear arch construction is shown in Fig. 4 and all-rear arch construction in Fig. 7. The height above the grate and length of arch or arches depend upon the kind of coal to be burned. The use of a front arch only was standard practice for a number of years, but with the wider use of chain grates, operating experience indicated considerable margin for improving gas mixtures and reducing the loss due to the hurling of small particles of coal over the rear of the grate and through the boiler passes. This brought about the development of the rear arch, which is now used extensively. This arch serves to divert forward the products of combustion and the excess air that is required in this area to clean up the combustible left at the rear of the grate. It also tends to increase the combustion in the rear portion of the fuel bed, thereby lessening the carbon loss to the ash pit.

The reverse flow of gas under the rear arch carries the fine particles of coal forward, and in making the turn upward into the secondary chamber redeposits a considerable portion of the fine coal upon the grate, where it insures rapid and positive ignition.

When burning bituminous coals with this type of stoker it is now general practice to admit secondary, or overfire, air at the front. The admission of this air, together with the increased velocity of the gases through the throat, tends to increase the turbulence and thoroughly mix the rich gases rising from the front of the grate with the lean gases from the rear, thereby promoting better combustion. Successful operation of chain-grate stokers is dependent largely upon adjusting the thickness of fuel bed and wind-box pressures to suit the kind of coal being burned. In general, anthracite fuel beds should vary from 3 to 5 in., bituminous fuel beds from 5 to 9 in. and coke breeze beds from 4 to 6 in. in thickness. The most economical fuel bed thickness is the thinnest one which will permit carrying the load without losing ignition or blowing excessive amounts of fuel off the grate. Variations in the ratings can best be obtained by increasing or decreasing the grate speed and air flow with little or no change in the fuel bed thickness.

The terms "chain grate" and "traveling grate," are commonly used synonymously. The two grates, however, are of distinctly different construction. The chain grate is comprised essentially of cast-iron links strung on rods which extend the full width of the grate. Two types of links are generally used: common cast-iron links and cast-steel drive links, the latter being spaced in rows from 15 to 20 in. apart across the stoker. These links engage the driving sprockets at the front end, and in operation the top strand of the chain is in compression, thus tending to maintain uniform air spaces between link ends.

Unlike the chain grate, the parts comprising the upper surface of a traveling grate which are exposed to heat and in direct contact with the fuel are not subjected to any mechanical stress. In this type carrier bars with clips attached form the

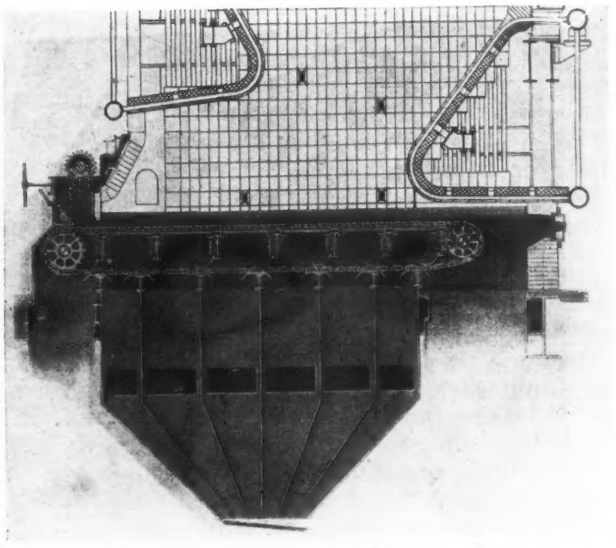


Fig. 4—B. & W. 1930 intermediate-type forced-blast chain grate with bottom air admission and water-cooled arches

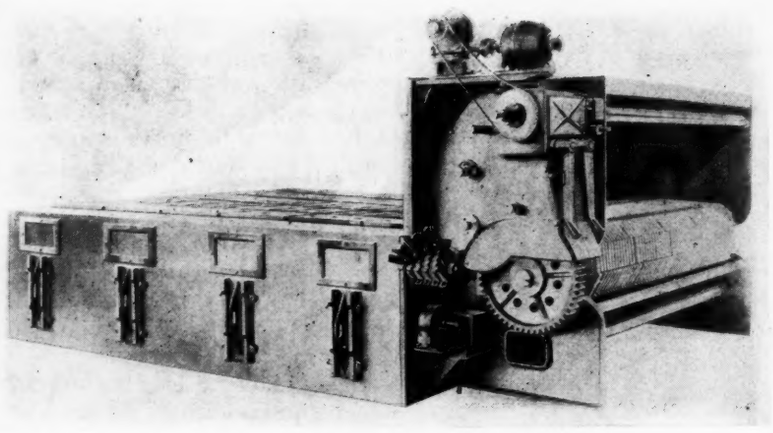


Fig. 5—McClave forced-draft chain grate with three-speed spur-gear drive

grate surface. The carrier bars are in turn attached to drop-forged steel chains which engage the driving sprockets and serve to propel the grate. In Fig. 2 the grate surface consists of a series of narrow castings or clips about $\frac{5}{8}$ in. wide, flat on one side and having projections on the other to separate the castings slightly and provide the air space. The top surface of the clips is either slightly rounded or flat, depending upon the duty for which the stoker is to be used. The curved surface of the clips tends to insure positive and uniform feeding of the coal, where necessary, from the hopper.

An improved design of clip is now being used to form the grate surface on the unit in Fig. 1. The new design provides for an overlapping of parts so that as the grate passes over the rear bearings of the stoker the ash falls clear and is not carried to the front. The clips are also designed to reduce to a minimum sifting of fine coal through the grate. This reduction in sifting has been effected by change in the overlapping and by designing the leading ends of the links to prevent their being readily burned, which would tend to increase sifting and affect the air distribution.

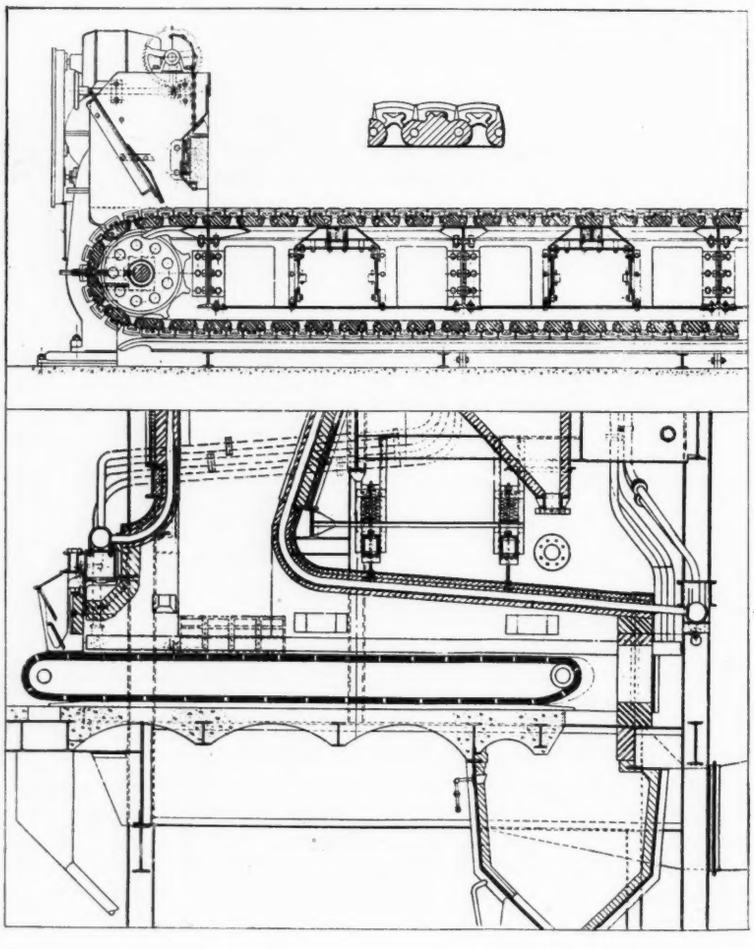
In place of carrier bars the lower chain of the traveling grate, Fig. 6, is composed of three or more strands of forged-steel drive links with cast-iron filler links between, mounted on $1\frac{3}{8}$-in.-diameter steel rods extending across the entire width of the grate. The top grate surface is composed of small clips, each $1\frac{1}{8}$ in. wide by $4\frac{1}{2}$ in. long, which when assembled overlap.

Traveling-grate stokers have found widest use in handling anthracite, semi-anthracite and coke breeze, which require forced draft and are particularly subject to sifting. They are also used successfully with free-burning bituminous and lignite coals.

In some designs air is admitted through both the lower and upper runs of chain by the introduction of bottom air admission, as shown in Fig. 4. With this arrangement all the air for combustion enters the stoker from below, passing through the bottom chain instead of entering between the chains from the side frame blast boxes as in the usual construction. By passing all the air through the lower run the chain is cooled to approximately the temperature of the air. This is of particular advantage where preheated air is used. Bottom air admission also tends to give better distribution of air across the grate.

In the stoker shown in Fig. 10 the cooling of the chain is effected by the use of a suction box or special air chamber immediately back of the front drive sprockets. The front vertical face of the box is provided with a series of holes through which boiler room air is drawn in through dampered openings in the stoker-front casing. The suction box is connected either to an individual fan or to the boiler breeching. The amount of air drawn through the chain for cooling is varied by means of the dampers according to the amount of preheat and rating being carried. This suction box also serves to prevent the escape of gases or ash dust from the casing inclosing the front of the stoker.

Fig. 6 (Top)—Playford forced-draft traveling grate. Fig. 7 (Bottom)—Green forced-draft stoker showing rear arch arrangement



A more recent design of traveling-grate stoker embodies the feature of a louver grate as shown in Fig. 3. Grate bars pivoted at their ends from holders arranged on driving chains, form the grate surface, taking the position shown in the upper part of the illustration. As the grate travels around the rear shaft the bars overbalance and rotate through an angle of about 90 deg. In dropping, the bars scrape against one another and are finally stopped by impact with the preceding bars. This action serves to free any material adhering to the bars. The siftings which fall through the air spaces are caught in troughs at the lower edges of the grate bars. Then when the bars overbalance on turning around the rear shaft the siftings are discharged and no other sifting removal mechanism is necessary. The air to the fuel bed is controlled in various zones from the front to rear by air valves operated from handwheels on the side.

Differing radically from the conventional chain or traveling grate is the unit in Fig. 9, in which the grate surface is made up of moving and stationary grates, the stationary sections comprising about 35 per cent of the entire grate area. Coal is fed on to the grate by pusher plates, the back-and-forth movement of which is adjustable to give various rates of burning. The fuel is carried down over the grate by the moving strands of chains.

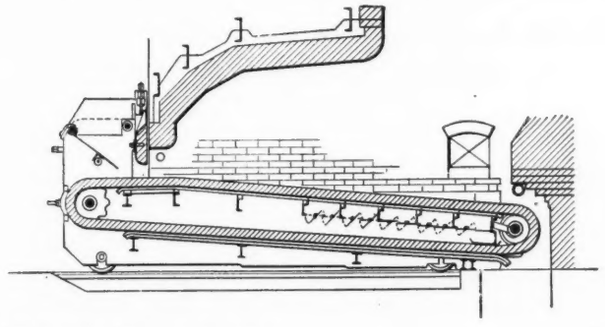


Fig. 8—Laclede natural-draft stoker with air controlling dampers below the rear half of the grate

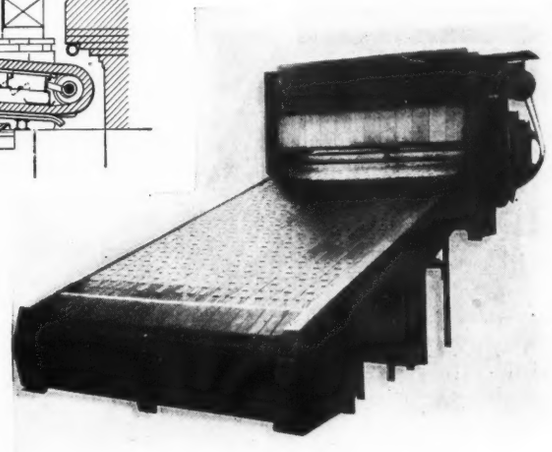


Fig. 9—Stowe stoker with alternate stationary and moving longitudinal grate section

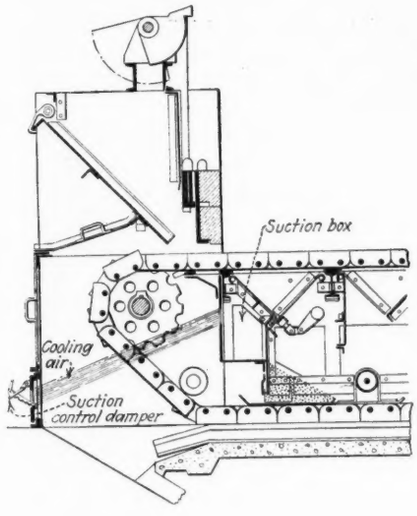


Fig. 10 — Illinois type G forced-draft stoker showing chain air cooling arrangement

Flexibility of speed control is an important item in the successful operation of chain-grate stokers. The average rate of travel of the grate surface is from 20 to 40 ft. an hour with maximum range from 5 to 75 ft.; hence a wide range of speeds must be provided by the engine or motor drive or in the stoker-driving mechanism itself.

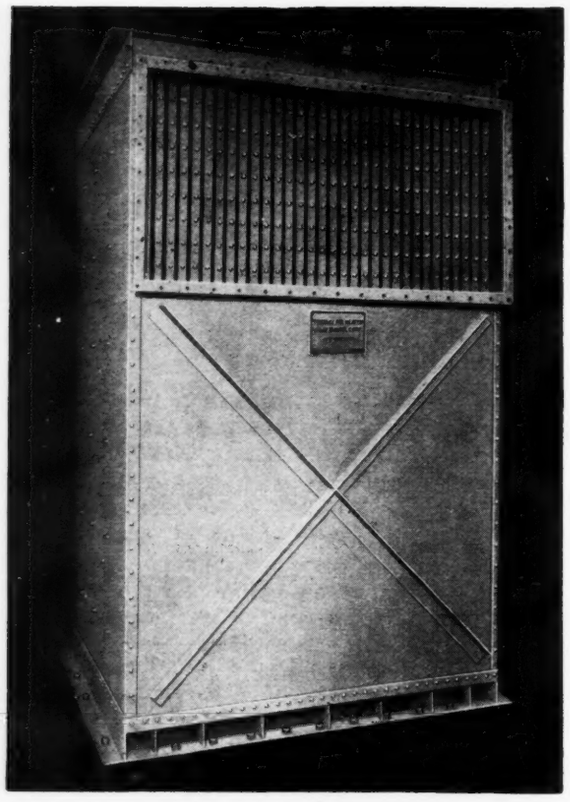
Three types of drive are in general use: ratchet driving mechanism; double-reduction, worm-gear drive; and straight spur gear reduction, with the initial drive from the motor or engine being made with a roller chain, flat or V-belt. In some drives employing an adjustable-speed motor and a double-reduction worm-gear or spur-gear transmission the entire drive is integral with the front drive shaft and moves forward or backward as the chain take-up bolts are adjusted. In Fig. 5 a constant-speed motor is employed and three speeds are provided by operation of hand levers on the front side of the gear housing as shown. The dampers for regulating the air to the various zones below the grate are also grouped in a convenient position on the front of the unit. The small motor and gear shown below the damper control operate the sifting scraper chains.

CHAIN- AND TRAVELING-GRATE STOKERS

Type	Approximate Grate Area Sq.Ft.	Grate	Draft	Manufacturer
Standard	Up to 138	Chain	N.-F.	Babcock & Wilcox Co.
Intermediate	90–235		F.	
Heavy duty	270–615		F.	
Coxe	30–600	Trav.	F.	Combustion Engineering Corp.
Green	25–275	Chain	N.	
Green	270–600		F.	
L	Up to 700	Louver	F.	
L	12–64		N.-F.	Illinois Stoker Co.
A	50–600	Chain	N.	
G	200–600		F.	
Stowe	48–360	Chain	N.-F.	Johnston & Jennings Co.
Kelco	25–60	Chain	F.	Kissick-Fenno Co.
Laclede	50–300	Chain	N.-F.	Laclede-Stoker Co.
McClave	45–216	Chain	N.-F	McClave-Brooks Co.
Harrington	50–500	Trav.	F.	Riley Stoker Corp.
Playford	90–400	Trav.	N.-F.	Rosedale Foundry & Machine Co.

Proper sizing of the coal ahead of the stoker and proper distribution of the coal in the hopper to prevent segregation of the lumps and fines are probably more important with a chain grate than with any other type, because no change can be made in the fuel bed after it leaves the hopper gate. If the fine and coarse coal are allowed to segregate in the hopper the fire will burn in ridges and excessive stratification of the gases will result.

This trouble has been lessened materially with certain classes of coals by proper tempering (moistening with water or steam). Although engineers are not agreed as to the value of tempering coals for chain grates, operating experience has shown it to be an advantage with certain classes of coals. Not only does it lessen segregation of the fines and coarse and reduce sifting through the grate, but it reduces the forced draft air pressure required, thus making it possible to burn more coal per square foot of stoker area. The tempering, however, must be done well in advance of the coal being discharged to the hopper if best results are to be obtained. Low-pressure exhaust steam has proved effective for this work.



Practical Comments

Due to the fact that an air preheater of the recuperative type has no moving parts and is, in principle, an extremely simple heat-exchanger, it is too often felt that no particular attention need be paid to it from the date of its installation until trouble occurs. It is true that very little time need be spent with the air preheater, but an occasional inspection will prove an investment yielding large returns

IN A FORMER article in *Power* (Aug. 25, page 271) there was a quotation briefly summing up the author's experience in the maintenance of air heaters. At the editor's request I have prepared this article, amplifying my previous remarks to cover all essential information in this connection.

With the advent of the air preheater in the United States, about eight years ago, it appeared to be an excellent method of reducing still further the temperature of flue gas and thereby of raising the efficiency of the boiler unit to points previously never even hoped for. The principal reason for this was that the gas can be cooled to a lower temperature than with an economizer, due to the fact that the temperature of the tube wall of an economizer is approximately the same as that of the water in the tubes, whereas the temperature of the wall of an air preheater is approximately the mean temperature of gas and air. Thus the dewpoint at a given gas-outlet temperature will not be reached on the air heater wall as quickly as on the economizer wall.

Plate Spacing Very Important

It will be of some interest to review the evolution of spacing in connection with plate-type heaters, as this has a bearing on maintenance. The tubular heater has remained with approximately the same sized 2½ in. tubes, but the plate-type heater offered the opportunity of a variable spacing and an increase in the coefficient of heat transfer as the spacing was diminished.

About ten years ago, when air heaters were first used to any large extent in Europe, the spacing ranged from 1 in to 1¼ in., without excessive reductions in gas temperature. Few difficulties were, in consequence, experienced in maintenance and operation. Shortly after the apparatus came into general use in the United States the manufacturers of plate-type heaters progressively reduced the spacing in both the gas and the air openings until a minimum of ½ in. was reached. This reduced the initial investment and space occupied for a given heat transfer.

It was not until later that increased maintenance costs caused the pendulum to swing in the opposite direction, and the spacing was consequently increased. Most of the gas spacing offered is at a minimum of ¾ in. and even as high as 1 in. Under certain conditions ⅝ in. spacing is permissible, but the conditions should be studied carefully before this is adopted.

The reason lies largely in the greater ease of cleaning with the larger spacing. In addition there is a certain amount of deflection of the plates toward the gas passages, due to the pressure of the air. On the other hand, the slight flection of the plates has a tendency to knock off deposits which might adhere to their surface.

The maintenance troubles which may exist in connection with air preheaters are due to the following: erosion, soot deposits, corrosion, moisture in the gas, moisture from soot blowing, low outlet gas temperatures, unequal distribution of gas or air, cold air in the winter, bypassing the preheater and starting up the furnace.

Erosion and Soot Deposits

Erosion is negligible in connection with air preheaters. In one case with which I am familiar all of the pulverized-fuel ash passes through the air preheater, with severe wear upon the fans, but at the end of a year's operation no noticeable wear occurred on the heater. On the other hand, a steam soot blower with high-pressure steam impinging upon the plates, due to incorrect position of the soot blower nozzles, may cause severe erosion. Exact centering of the jet, so that it will blow straight upward into the gas, is an essential feature of design.

on the Maintenance of Air Heaters

By LOUIS C. WHITON, Jr.
President
Prat-Daniel Corporation

A deposit of soot in the form of unburned carbon is relatively rare. This is possibly due to the fact that the soot is light and flocculent and does not adhere firmly to the plates or tubes unless mixed with the products of corrosion. The deposit of soot is usually swept away by the gas velocity of 20 or 30 ft. per second through the air heater.

With a banked condition of the furnace or a bypass of the air heater, deposit of carbon may result. The avoidance of this will be discussed later under "Bypassed Preheaters." Deposit of ash on the plates or tubes with pulverized-fuel installations does not occur to any marked degree.

Corrosion infrequently occurs to a degree where the plates will be eaten through, but frequently occurs sufficiently to cause complete blocking of the heater. This is due to the formation of iron sulphate salts, which are extremely hygroscopic and which collect soot and fly ash, thus forming a very troublesome deposit. This is probably the most important feature in connection with the maintenance of air preheaters and it can be avoided if proper design and operation are followed throughout.

Improper layout of ducts, so that the air and the gas are not distributed evenly over the inlet to the air heater, will cause blocking up in certain of the elements or the tubes and not in others. This improper layout of the gas duct may also cause a collection of cinders on top of the air preheater in case the passage of gas is straight upward. Although fly ash and cinders may pass through the air preheater, they may collect due to eddy currents and pile up on top. Moreover the sudden drop of velocity in the duct at the top of the heater may cause them to fall back, which may start a condition of unequal flow through the air preheater, with consequent corrosion. Dust collection on top of the air preheater is relatively easy to remove if observed in time.

It is preferable to avoid any turn of the gas within the air preheater itself. Rather than have an *S*, *C* or *L* flow for the gas, it is better to shorten the length of the heater plates so as to have the turn in the direction of the gas occur in a free duct that can easily be cleaned. Ideal design would be straight downward flow for the gas, as this would collect the cinders in the soot-box at the bottom.

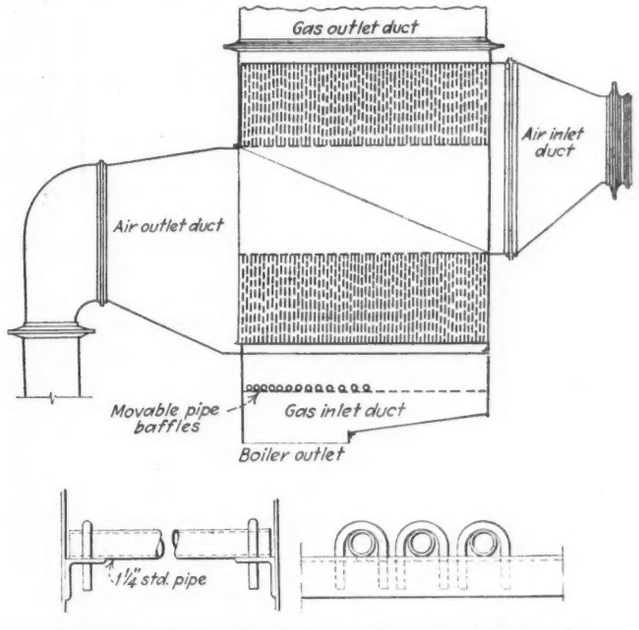
Causes of Corrosion

The causes of corrosion are numerous: Sulphur emanating from the coal can occur in three forms, organic sulphur, sulphides (such as iron pyrites) or sulphates. Organic sulphur and sulphides are converted in their entirety to supply dioxide and sulphur trioxide. The sulphates remain in the ash and do not cause any difficulty. Therefore knowledge of the total sulphur content of a coal, without any distinction between one or the other forms of sulphur, is of relatively small value.

Sulphur dioxide or trioxide has little action upon iron, provided there is no moisture; but as soon as moisture is deposited upon the plates or tubes, corrosion starts rapidly. As pointed out in the article by H. S. Johnston in the May 26, 1931, number of *Power*, the strength of the acid formed upon the plates will reach as high as 70 to 90 per cent sulphuric acid.

Moisture in the gas is therefore of importance to consider with the sulphur. Common impressions as to the amount of moisture from various fuels are frequently in error.

The two primary heat-forming substances in fuels



Arrangement at Toronto, lower view showing Thermix pipe gratings

are carbon and hydrogen. The carbon normally burns to CO_2 and the hydrogen to H_2O. To this must be added the water already present in the fuel. The higher the ratio of total hydrogen in a fuel to the carbon, the greater is the weight of moisture per pound of flue gas.

The average value of this ratio for various fuels is as follows:

Anthracite	0.032
Bituminous	0.066
Lignite	0.069
Fuel oil	0.144
Natural gas	0.306

The moisture then increases in the order shown, although not in direct proportion to the ratios tabulated.

Use of Soot Blowers

The use of a soot blower with an air preheater is to be desired. It is simpler to install in connection with a plate-type of heater. If it happens that the length of plate is too great, a steam lance introduced through holes at the side of the preheater should also be used. The advantages of a soot blower may be nullified, however, if the steam or air used in it is not absolutely dry. Ejection of water upon the plates, especially during operation, will aggravate the corrosion difficulty.

Therefore, a proper drain and a carefully insulated steam line should be installed in connection with the blower, and the steam or air should be bled to the atmosphere before it is allowed to blow through the heater plates or tubes so as to avoid introducing any water. The blower should not be operated when the heater is cold, because of the resultant moisture precipitation.

Compressed air generally carries large amounts of moisture, and practically the same procedure should be followed with either steam or air used in connection with the soot blower.

Water washing of the plates or tubes is an excellent method of cleaning the preheaters, provided the collection has not exceeded a certain quantity. If the washing is done at the end of a shutdown period the plates may be subjected to rusting. It has been recommended that the heater be washed just before the boiler is started up, so that the plates or tubes will be dried immediately.

I know of an oil refinery where the plates upon which ferrous sulphate had formed were first wet with a solution of sodium ferri-cyanide, which it was claimed loosened up the ferrous sulphate with the formation of Prussian blue. This would appear to be a rather expensive chemical to use for this purpose. Soda is generally sufficient. At the same plant it was stated that iron sheets were hung in the flue before the air heaters and that considerable corrosion occurred on these sheets, sparing the air heater that much chemical reaction. This, however, could occur only if the gas were cool enough to precipitate moisture.

Because the designing engineer desires to remove as many heat units as possible, he frequently specifies an outlet gas temperature which is reasonable for the normal operating rating of the boiler but becomes dangerously low at less than its normal rating, then reaching the dewpoint of the gas. It is axiomatic that the low temperature and not the high temperature is the usual cause of trouble in the operation of an air preheater, and this low point should be carefully considered in any design.

Effect of Duct Layout

As already mentioned, an incorrect duct layout may subject certain portions of the air heater to gas below its dewpoint due to overcooling of the air at that point. For example, a plate-type air heater designed for straight vertical passage of the gas frequently has the inlet or outlet duct make a right-angle turn. This turn should be in the direction of the plane of the plates and not perpendicular to it. There will be a more even distribution of the gas throughout the air heater in this case than if the duct should enter or leave at the end of the air heater. In the latter case more gas would pass through the sections nearest the right-angle turn.

Baffles May Cause Trouble

Baffles have been used to some extent to create an equal distribution of gas and air throughout the air preheater, but the company with which I am connected has made extensive research on the flow of air. A wooden board, painted black, the size of an air preheater plate, was covered with a sheet of glass placed at the usual distance between plates in an air heater.

Baffles of various designs were tested out when forcing through the system air mixed with titanium tetrachloride, which produces a white fume. When measuring the space swept by the fume little difference was found with the usual types of baffles, unless an extremely high resistance was created by a type of baffle not permissible in practical operation. The ordinary C flow with C-shaped baffles has a tendency, unless carefully designed, to permit more air to pass through the inside of the circuit than the outside, since there is less resistance at the inside. Precipitation of moisture in the adjacent gas sections is therefore more likely to occur at a point corresponding to the inside of the air circuit, since there is greater gas cooling at this point.

Considerable care should be taken to avoid any air leaks into the gas ducts at the inlet of the air heater, since the continuous cooling of a stream of gas with cold air at a specific point may set up a nucleus of plugging material.

Pipe Baffles at Toronto Station

Where circumstances make it impossible to obtain an ideal layout at the inlet and the outlet, baffles in the duct may be able to correct this condition. In the installation of thermix air preheaters at the Toronto (Ohio) station of the Ohio Edison Company, the space for the air preheaters between the boiler outlet and the induced-draft fan was unusually small and the long narrow boiler outlet had to be transformed by a piece of duct work to the full area of the bottom of a 36,000-sq.ft. air preheater.

In order to properly distribute the gas, 1¼-in. pipes were laid upon racks in this inlet duct. They could thus easily be increased or decreased in number and rearranged in position until the distribution of the gas was as perfect as possible at the inlet of the air heater. No difficulty has ever been experienced due to this unusually difficult arrangement for the inlet duct.

Bypassing Air and Gas

Probably one of the greatest causes of plugging in an air heater has been the incorrect installation of a gas bypass. An air bypass must always accompany a gas bypass. It will be appreciated that if the gas is bypassed and the air is allowed to flow through the heater the small leakage of gas passing through the dampers will cause an extreme cooling of this gas. In case of a partial blocking up of the heater, which increases the draft loss through it, it is frequently the practice to

open up the gas bypass somewhat to relieve the insufficient draft in the furnace.

The condition is aggravated if the full quantity of air is passed through the heater with the diminished quantity of gas. It is therefore important that at any time any of the gas is bypassed through an air preheater an equivalent or greater amount of air must also be bypassed through the air bypass.

The use of the air bypass may be found necessary also if, in certain installations, due to a change in fuel or some other reason, lower exit gas temperatures are encountered than were originally anticipated. It is not possible to diminish the surface of the heater, because the blocking off of a number of gas sections will increase the gas resistance to too great an extent. It is only practical to bypass a portion of the air in such an instance.

A blast of cold air upon the heater plates will have the usual effect of cooling the gas to too great an extent. It should be remembered that the room from which the air is taken should be as warm as possible, especially in the winter time. If the air from the boiler house which has been heated by radiation is used, this, of course, recovers the heat which would otherwise be lost from radiation. There are several ways this difficulty, which may occur in the winter time, can be modified.

Recirculation

If some of the heated air (generally under pressure) from the outlet duct of the air heater is allowed to flow back to the inlet of the fan so as to temper the air, there will be a somewhat increased fan horsepower, but maintenance conditions in the air heater will improve. It is not necessarily required to attach a duct to the inlet of the air fan, but merely to blow the heated air close to the inlet.

If a bypass duct exists for the air, a certain amount of cold air may be permitted to bypass to the outlet duct for the heated air. The diminished quantity of air will sometimes remedy the situation and no additional fan horsepower will be required.

In one case steam coils using waste low-pressure steam were used to heat the air at the inlet of the air heater. Provided the heat-balance makes this feasible, it appears to be an excellent method of procedure.

When starting up a furnace or when banking a fire, both the air and the gas should be bypassed around the air heater, if possible, since there is too much surface for the reduced quantity of gas and too much cooling will occur.

Bulging of Plates

In a few cases bulging of plates in plate-type air preheaters has been observed in spite of struts placed over the surface of the plates, which theoretically should prevent any bulging as far as the air pressure upon the entire surface of the plates is concerned. This bulging is practically always due to high temperature of the heater plates from secondary combustion. In one wood-burning installation the recording thermometer indicated that the gas before the air preheater never exceeded 600 deg. F., and yet extreme bulging occurred. This was probably due to the collection of wood upon the top of the air preheater, since this was a down-pass heater and the charcoal eventually ignited and buckled the plates with high temperature, as was evidenced by the mark of flame on the duct work at the outlet of the heater.

When heaters are to be shut down for any extended period of time it is well to wash them with a dilute solution of sodium carbonate and, after the plates are dry, to spray them with a light petroleum oil to prevent rusting during the shut-down period. All doors and inspection openings should be kept open so that there will be a slight air circulation throughout the heater. Under these conditions it should be possible to shut down a heater for a number of years without any deterioration whatever.

It must not be concluded from the foregoing that operation of air preheaters is especially difficult. It is only a few years since they were introduced in the United States. Although operators are familiar with the points to watch out for in the operation of their boilers, they are not yet as familiar, in many cases, with their air heaters. The increasing general use of this type of apparatus indicates that the air preheater is relatively easy to maintain and operate. Yet it must not be considered an apparatus that once installed need never receive intelligent care thereafter.

Summing up, it might be stated that although it is wise to design for high efficiency of heat recovery and low cost of air preheater, it is better to sacrifice some efficiency than to run into maintenance difficulties. By the same token it is better to have wider spacing, which means a slightly increased surface and initial cost, than to have too small spacing, which may cause difficulty in cleaning and maintenance costs.

Finally, every precaution should be taken to avoid the precipitation of moisture and sulphur acids upon the plates from any one of the several causes mentioned.

▼

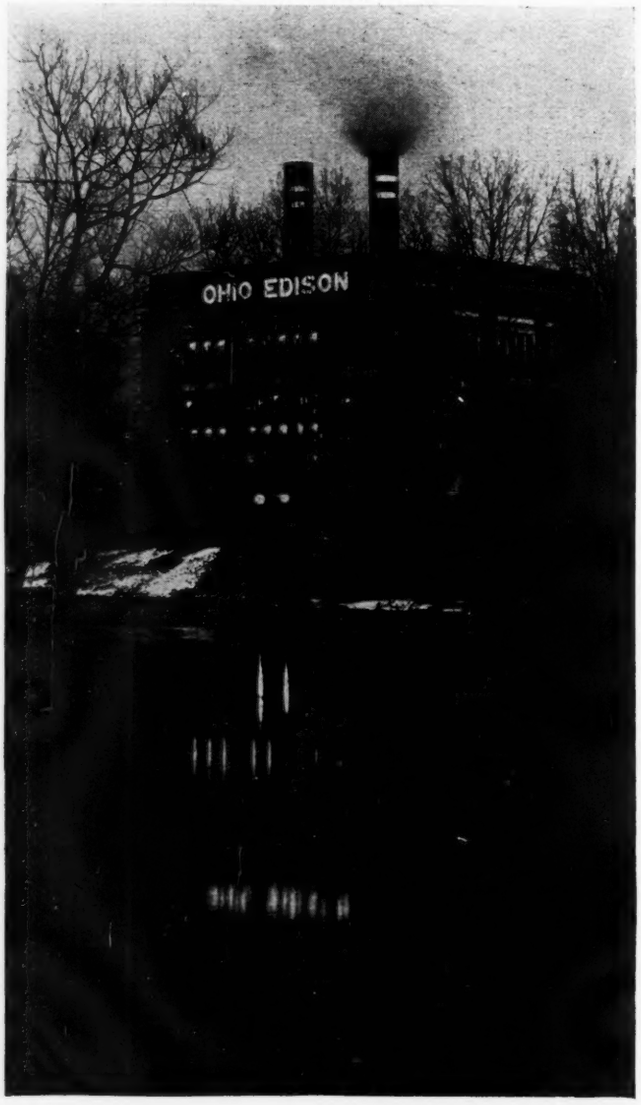
Banking Oil-Fired Boilers

A GREAT DEAL of trouble was had at a plant equipped with oil-fired boilers in banking overnight. The plant supplied a factory with power and process steam and shut down every night until the following day. There was no boiler room attendant through the night. If the burners were shut off too soon the pressure would be so low and the furnace cooled off so much by morning that considerable time and fuel were lost in starting up. On the other hand, if the burners were left on until the last minute the furnace temperature would be so high as to cause generation of steam through the night and the safety valves would open a number of times.

As the load was variable, the furnace temperature and time required to cool sufficiently to shut the dampers and boiler stop valves were different each day. The fireman had been guessing at it by the redness of the brickwork, but it was impossible to judge it by this method.

A method which proved successful was to bore a $\frac{3}{4}$-in. hole in the side of the brickwork about 4 in. deep. A thermometer fitting of the 90-deg. type was inserted and the space around the well was filled with clay. After several trials it was found that if the dampers and stop valves were closed when the temperature at this part of the furnace wall had dropped at 260 deg. F., 50 per cent of the steam pressure would exist at the end of thirteen hours. Attempts to leave the plant with any higher temperature at this part of the furnace resulted in a loss of steam through the safety valves. Although the required temperature and pressure in different boilers varied, this method should work out in other plants of this type.

Soot Blower Operation at Mad River



By J. W. MIKELS
Production Department
Ohio Edison Company, Youngstown, Ohio

The July 15, 1931, number of Power carried an article describing the Mad River station of the Ohio Edison Company at Springfield, together with the experiences resulting from two years' operation of this station. The present article gives useful information on the part soot blowers have played in the efficient operation of this plant as well as on the maintenance costs of this particular equipment

MUCH of the information reported concerning soot blowers deals with steam consumption, labor and maintenance. In existing installations the important question in the operator's mind is that of maintenance. This factor is also widely discussed whenever new soot blowers are proposed. From the standpoint of justification from savings effect, the calculations of the fuel savings from the flue gas temperature differences are readily made, and they are dependent in magnitude upon fuel costs, quantity of fuel burned, type of installation and the load factors under which the boilers of the individual plants are operating. The savings made and properly credited to soot blowers as resulting from the prevention of slag formation are somewhat more difficult to evaluate. They are practically dependent upon the same factors as those in the calculation of savings due to flue gas temperature differences. Such items as increased steaming capacity from a slag-free boiler, reduced power consumption by the draft auxiliaries and the fuel savings due to keeping the boilers "on the line" are of considerable importance. These, when properly evaluated, should be credited to the savings effected by soot blowers.

The results obtained by the use of mechanical soot blowers at Mad River, as well as figures on maintenance costs, were obtained from actual operating practice and cost records which have been kept over a four-year period that started with new plant operation in August, 1927.

Twenty Soot Blowers per Boiler

The boiler plant consists of two 12,750-square foot B. & W. boilers. These boilers were described briefly in the July 15th number of *Power*, as were the economizers and fans. The annual average rate of coal burning is approximately 17.3 lb. per square foot of grate surface per hour. The maximum coal-burning rate for 10 hr. is approximately 35 lb. per square foot of grate surface per hour.

Eight soot blower elements are inserted from each side of the boiler, each extending about half way across the width of the boiler. Each economizer has four elements. Location of these elements is shown on Fig. 1, *A* to *L*. The *A* and *B* elements are of dialoy, suspended about 3 in. from the face of the tubes. The *C*, *D* and *E* elements are calorized, and the rest are of extra-heavy steel. Most of the difficulties have been with those at *A*, due to the extremely high temperature at this point and on account of their extra length. This distance and

the lack of cooling from the boiler tubes causes them to burn and warp rapidly. The short life of the bearings at this position is also one of the direct causes for the frequent renewals of the elements.

Steam from the outlet of the convection superheater at about 400 lb. gage and 600 deg. F. temperature is used for soot blowing. This is supplied through a $2\frac{1}{2}$-in. line with chain-operated globe valve. A throttling orifice of $1\frac{3}{8}$-in. fixed diameter is placed in the main soot blower header line. The operating heads are the valve-in-head type.

The blowers are operated once daily about midnight unless observed conditions warrant blowing them more often. The regular operating crew takes care of this work. The time required for blowing the boiler and economizer soot blowers is about forty-five minutes.

Maintenance Costs and Experiences

With a total of 40 soot blower elements installed in the two boilers, after four years of operation, 10 elements have been replaced with new ones, and these all in the *A* position. The year of greatest element replacement was 1930, when 6 elements in the *A* position had to be replaced. This was due to an experiment with calorized elements in this position. They proved unsatisfactory, as they had an operating life of about six months as compared to approximately twelve to eighteen months life of the dialoy elements. The replacement cost of the calorized element, including labor, was approximately $60, and the dialoy element about $130. The bearings which support the elements have been replaced once since the original installation.

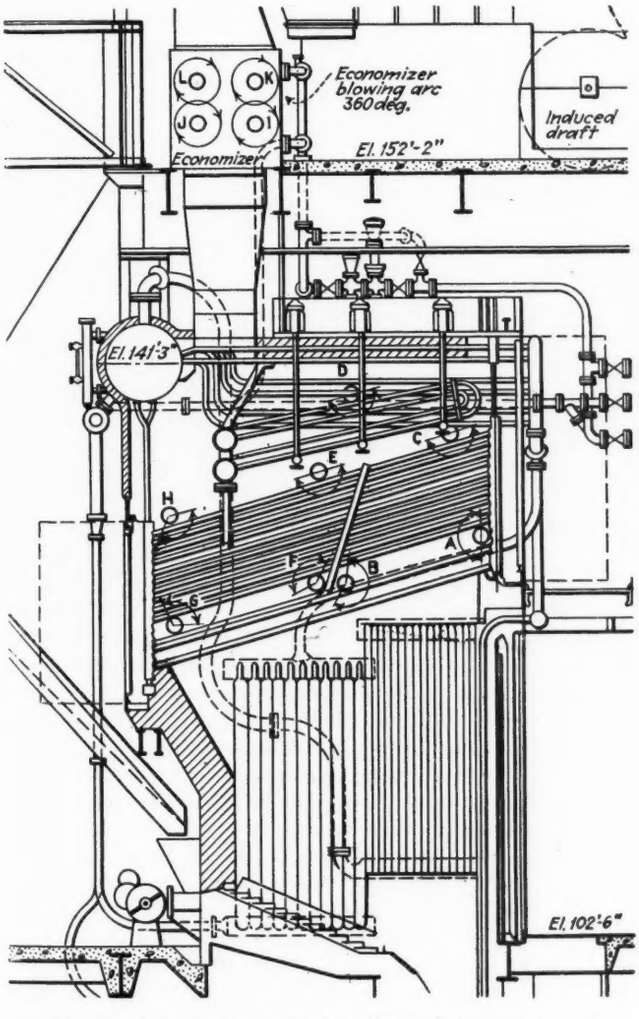


Fig. 1—Cross-Section of Mad River boiler with soot blower locations indicated

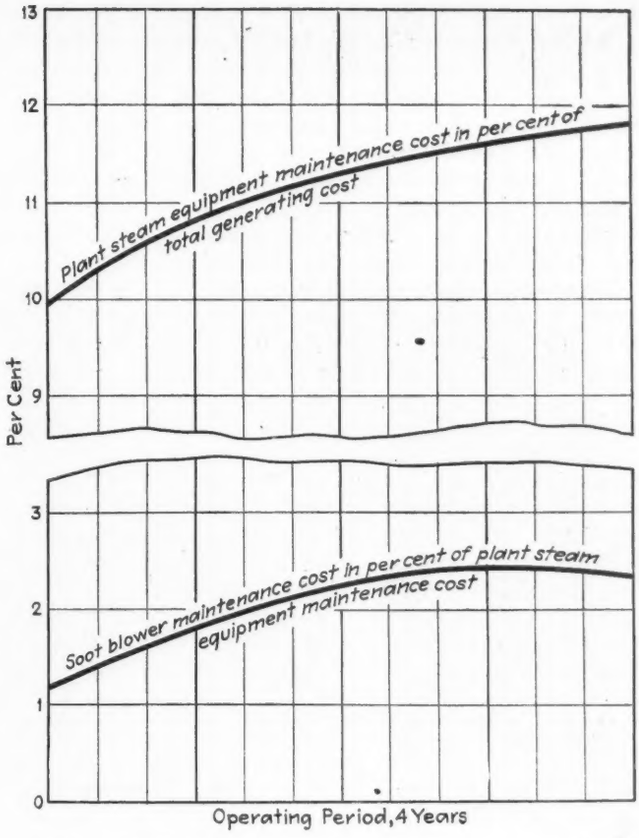


Fig. 2—Soot blower maintenance in per cent of total maintenance

The upper curve of Fig. 2 shows annual plant equipment maintenance cost in per cent of the total plant generating cost. The lower curve shows soot blower maintenance cost in per cent of annual plant equipment maintenance cost. This comparison serves to show the relation of soot blower maintenance to total maintenance.

Fig. 3 shows the relative annual maintenance cost between labor, element renewal, and maintenance costs of bearings, valves, packing and piping. The total curve shows that after three years of service, the maintenance costs reached their peak and thereafter have remained at practically a fixed annual amount. The average maintenance over a four year period shows a cost of 8.63 per cent of the initial installation cost as the annual cost of upkeep for mechanical soot blowers.

Tests on Effectiveness Against Slagging

During the forepart of 1929 the *A* soot blower elements in both boilers became inoperative. A test was made on the effectiveness of these blowers by the failure to renew them immediately. The result was that slagging difficulties required immediate attention. The slag formation started on the surfaces of the first row of tubes and extended through the convection superheater, with the tube passes at sections completely blocked. When this element was inoperative it was necessary, about every three weeks, to put a gang of four to six men on the job of hand deslagging. The direct labor cost was high, and in addition there was a loss due to keeping the boilers "off the line." The smaller of the motor-driven induced-draft fans was capable of provid-

ing sufficient draft for about 250 per cent of normal rated boiler output under the heavily slagged condition. After its removal and further prevention, the same fan was capable of furnishing draft for 300 per cent of normal rating. After soot blower renewals at the *A* position the heavy slagging was prevented. The slag which existed thereafter in the first pass did not extend beyond the slag screen.

Referring to Fig. 1, the *B* elements are not being used. They became inoperative after the first six months of operation. Because of their extremely short life on account of excessive temperatures, these elements have not been replaced. No operating difficulties attributable to their failure to operate have been noted.

Warping Corrected

The *A* elements warp occasionally when the inside bearings burn off and leave them unsupported. They are successfully straightened by heating to a cherry red in a forge and then pounding with a heavy wooden block on a smooth surface. All of the nozzles are usually in good shape on the blowers which are removed. Complete drainage of condensed steam from the system and completely shutting the header valves after blowing probably accounts for lack of trouble with nozzle failures.

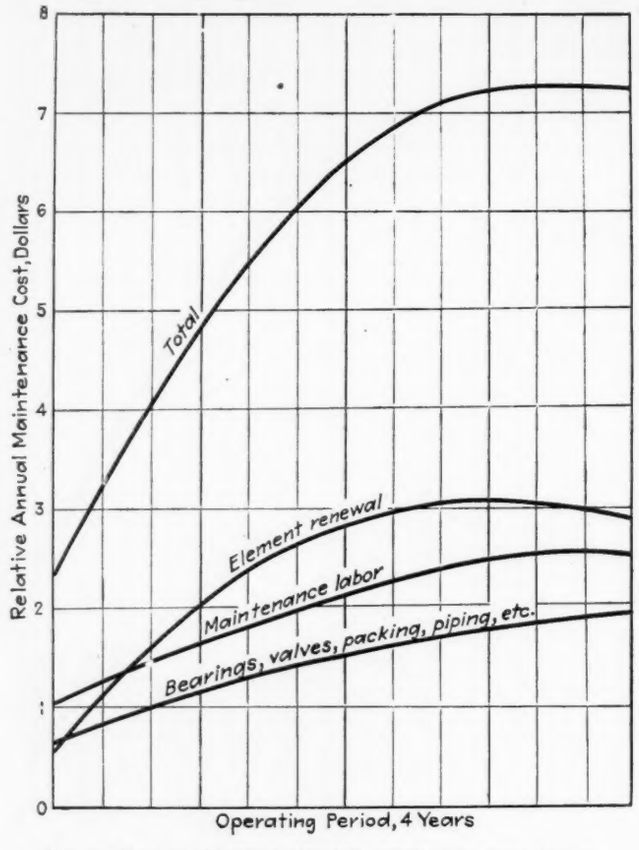


Fig. 8—Cost of different elements making up soot blower maintenance

Soot blower header valves have caused considerable annoyance from leakage. These are 2½-in. steel valves with monel-metal seats and disks of the short bevel type. Ordinarily they would remain practically tight for about six weeks of operation. After this period the seats and disks would have to be machined or ground for reseating. Two of the header valves have been equipped with stainless-steel cone-type seats and disks. These seem to stand throttling service much better, operating about three months without serious leakage and consequent repair. The practice by the operators in snugging down the valve seat against the disk after the temperature of the metal has been reduced, a short time after the blowing operation, seems to have aided also in keeping these valves tight.

Some difficulties have been found with blower head packing. Much of the packing used had a tendency to grab the hot element after short service. Although no serious objections came from steam leakage, this packing

RESULTS OF EIGHT-DAY TEST ON SOOT BLOWERS

	Elements Blown												Affect on Temperatures			
	A	B	C	D	E	F	G	H	I	J	K	L	Boiler Outlet	Steam	Water Econ.	Gas Outlet Pre-heater
1st day	..	..	..	x	x	x	x	x	x	x	x	x	None	None	None	None
2nd day	..	..	..	..	..	..	x	x	x	x	x	x	None	None	None	None
3rd day													None	None	None	None
4th day													Slight increase	None	None	Rising
5th day						All blowing omitted							Rising	None	None	Rising
6th day													Rising	None	None	Rising
7th day													No observations made			
8th day	..	..	..	x	x	x	x	x	x	x	x	x	40 deg. drop	Same	10 deg. rise	40 deg. drop
9th day	x	x	x	x	x	x	x	x	x	x	x	x	50 deg. additional drop	Same	Same	5 deg. additional drop

x shows elements blown.

Comparative Draft Change During Test

	Before	After
F. D. fan outlet	5.75	5.75
F. D. wind box	0.70	0.60
F. D. rear comp	0.62	0.58
O. F. draft	—0.05	—0.15
First pass	—0.07	—0.165
Boiler outlet	—0.25	—0.40
Economizer outlet	—0.50	—0.75
Preheater outlet	—0.70	—1.00

seizure was bothersome. For our purpose Durametallic packing has proved to be most successful.

Another difficulty we attributed to soot blowers was the renewal of two boiler tubes in one of the boilers in the last pass, immediately above the *G* element. This blower was formerly driven in a clockwise position on one side of each boiler. The arc of blowing began by blowing directly against the tubes and ended parallel with the baffle. The tubes above became badly cut, probably due to the direct sand-blasting action of fly ash which collected and covered the blower nozzles at the beginning of the blow.

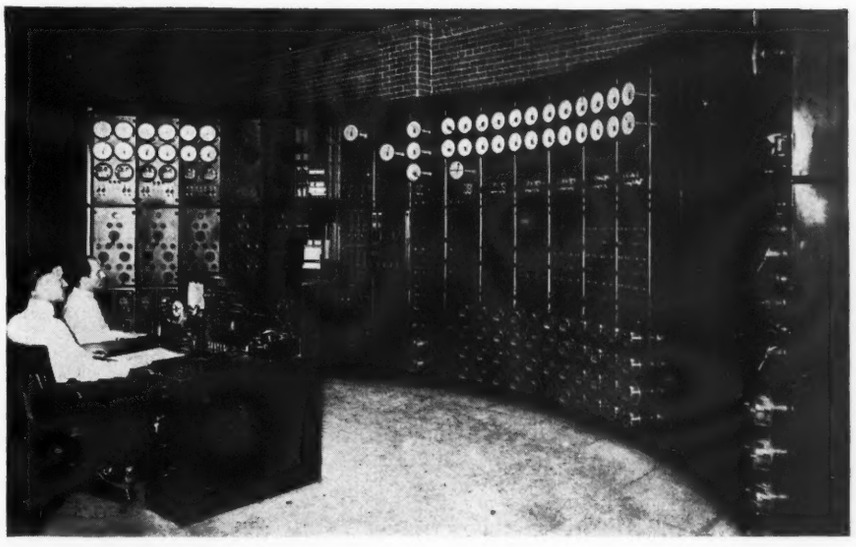
Clockwise-driven heads were exchanged by the soot blower manufacturer for counter-clockwise heads. The blowing now begins parallel to the baffle and the abrasive ash is thus dislodged without blowing it directly against the tubes. No further tube-cutting has taken place since this change.

Clean Tube Surfaces Most Important Effect

The ability of the soot-blowing apparatus to maintain exit gas temperatures without abnormal rise is important, but of greater importance is the clean tube surfaces that result. Formation of slag on and between the tubes of the boiler and superheater constitutes a serious menace to the continuity of boiler operation and sooner or later it must be removed. It has been our experience that mechanical blowing provides an efficient and economic means of reducing the slag formation to a minimum. This result can be brought about only by keeping the blowers in operating condition at all times. Inspections must be made of the condition of the element, blowing arc, condition of packing and general operating conditions whenever the boiler is off the line for repairs. Strict attention must be paid to the daily inspection reports of the operators.

New Specifications for Power Control Cables

In a previous article, Nov. 10 number, an outline of the new developments in control cable were given. This story tells what is being done to create new specifications incorporating the latest advances in cable construction



A STANDARD color code for individual conductors in multi-conductor control cable was studied during 1930 by the electrical apparatus committee of the N.E.L.A. For the first time in this country there is now available in a specification of a national association a standard control-cable color code and is given in the table. This code is incorporated in the National Electric Light Association's proposed specification, "Rubber-Insulated Station Wires and Cables," and was approved in principle by the association's electrical apparatus committee Feb. 18, 1931, at St. Louis, Mo. While this specification includes other types and sizes of wire and cable for general station purposes, it is the most comprehensive specification on control cable which has been issued.

In preparing this color code the committee not only studied current practices, but made tests to prove what color combinations were the most suitable. An article, "Standard Control-Cable Color Code Approved," by G. Southerland, in *Power*, Jan. 13, 1931, discussed this color code and how it was formulated.

The object of the specification is to require furnishing the highest quality material in accordance with best accepted practice. However, the manufacturer is allowed to submit alternative clauses with his proposal if he believes this specification is not consistent with that intent.

The rubber insulation is to be a high-grade 30 per cent Hevea rubber compound either meeting specification D27-28T of the A.S.T.M. or latest revision, or those meeting the requirements for 30 per cent performance test compound. To prevent the rubber compound from adhering to the conductor a paper or cotton wind separator shall be used over the copper. The physical characteristics of rubber are given in the table.

The term 2-6 in. means that marks 2 in. apart are made on the sample, which is then stretched until the distance between the marks has been increased to 6 inches.

Accelerated aging tests may be made at the option of the purchaser by the Geer dry-heat and the Bierer-Davis oxygen-bomb methods. Requiring these tests to be made is in line with the new development in inspecting rubber-insulated cable and means that when a customer requires these aging tests the new types of compounds containing the new organic accelerators and anti-oxidants are desired.

Electrical tests are made on the individual conductors after twelve hours immersion in water, but no final tests other than visual inspection and tests of flameproof braids are required.

It should be noted that this specification omits any mention of chemical analysis of the rubber insulation. This gives a simplification over previous specification and allows the manufacturer greater leeway in producing the latest improved type of rubber compound.

In regard to the rubber insulation, the intent of the specification is to allow using either the older standard types of 30 per cent Hevea rubber compounds of the highest grade or the newer types of compounds containing at least 30 per cent new Hevea rubber with the organic accelerators and anti-oxidants and known as performance-test compound. To explain what is meant by performance-test compound it is necessary to mention three general types of wire and cable specifications.

A customer from past experience may have found that cable construction with a certain type of rubber compound has given satisfactory service. As cable is bought mainly on competitive bidding, the purchaser specifies in detail in his specification the materials and construc-

	Minimum	Maximum
Tensile strength, lb. per sq.in.	1,200	.....
Set in 2-in. gage length after elongation to 6 in.	.....	$\frac{1}{2}$ in.
Elongation, per cent	400	.....
Stress lb. per sq.in., 2–6 in.	300	.....

tion of the cable so that he will obtain a similar product from any manufacturer. This is known as a "materials" specification.

The manufacturer prefers to have freedom in making use of any improvement in materials, processes or construction, as these may be developed without disclosing them to the customer and having them approved. He therefore favors another type of specification known as the "performance" specification, which is based on the theory that any materials or type of construction may be used as long as the cable passes certain tests which establish that it is suitable for the required service. This allows the manufacturer complete freedom to adopt immediately any improvements in the art.

There are arguments in favor of both types of specification. A compromise type is now being used by some purchasers in which they have adopted the required performance tests and allow the use of the newest ingredients which they specifically mention. Therefore a performance-test compound is one which will pass certain specified tests but which is not limited to the use of certain specific materials.

A practical solution of the most desirable type of specification seems to be the plan which is incorporated in the new N.E.L.A. specification for rubber-insulated wire and cables. Paragraphs are inserted in this specification which read: "The purpose of this specification is to require the furnishing of highest-quality material manufactured in accordance with this specification and the best accepted practice.

STANDARD COLOR SYSTEM FOR CONTROL CABLE SPONSORED BY THE JOINT N.E.L.A AND N.E.M.A COMMITTEE

Base	Tracer	Tracer	Base	Tracer	Tracer
1—Black			19—Blue	Red	
2—White			20—Red	Green	
3—Red			21—Orange	Green	
4—Green			22—Black	White	Red
5—Orange			23—White	Black	Red
6—Blue			24—Red	Black	White
7—White	Black		25—Green	Black	White
8—Red	Black		26—Orange	Black	White
9—Green	Black		27—Blue	Black	White
10—Orange	Black		28—Black	Red	Green
11—Blue	Black		29—White	Red	Green
12—Black	White		30—Red	Black	Green
13—Red	White		31—Green	Black	Orange
14—Green	White		32—Orange	Black	Green
15—Blue	White		33—Blue	White	Orange
16—Black	Red		34—Black	White	Orange
17—White	Red		35—White	Red	Orange
18—Orange	Red		36—Orange	White	Blue

Base	Tracer	Tracer
37—White	Red	Blue

"If any manufacturer in submitting a proposal believes from his experience that this specification is not consistent with this intent, he should submit alternative clauses with his proposal."

The A.S.T.M. has revised its Tentative Specifications D27-28T to allow the use of the new types of rubber compounds. This specification is now known as D27-31T compounds. The compounds allowed in this specification are:

1. The old standard types of high-grade 30 per cent Hevea, called Class A compound.

2. The new types of rubber compounds which make use of the organic accelerators and anti-oxidants, and called "Class AO" compound.

A sub-committee is working on a "Tentative Performance Specification," which is intended to be included as an appendix to specification D27. It is expected that the completed specification will be issued in 1932.

The A.S.T.M. is also revising its specification D297, "Tentative Methods of Chemical Analyses of Rubber Products," to cover the use of organic accelerators and anti-oxidants

CURRENT COMMENT

One Compensator Starts Two Induction Motors

NOTICING, in *Power*, Oct. 6, the article entitled "One Compensator Starts Two Induction Motors," it occurred to me that a method we have used might be of interest.

When installing an additional crusher in our plant, it was thought desirable to add a 15-hp. motor to run the elevator and screens, leaving the original 27-hp. motor to handle the two crushers.

To save the cost of installing a new compensator, the new motor was connected into the existing starting circuit as shown in the diagram. To start motor No. 2,

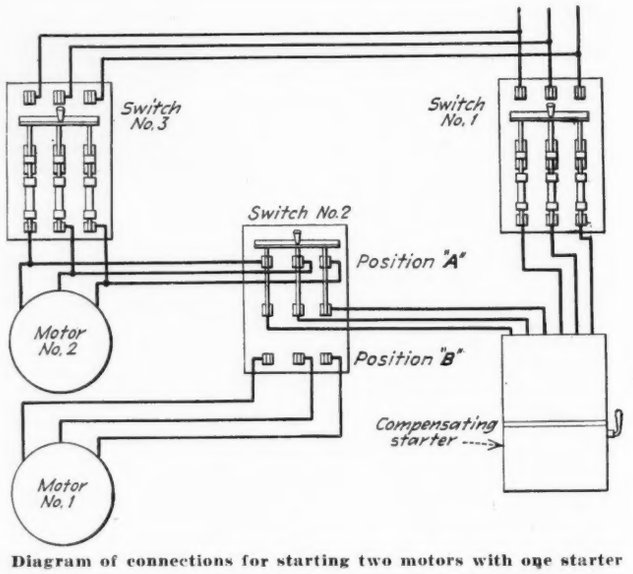


Diagram of connections for starting two motors with one starter

switch No. 1 is closed, and switch No. 2 is closed in position *A*. Operating the compensator thus starts motor No. 2. When up to speed, switch No. 2 is opened (automatically releasing the compensator) and switch No. 3 is closed, throwing motor No. 2 across the line. Switch No. 2 is then closed in position *B*, and motor No. 1 is started in the usual manner.

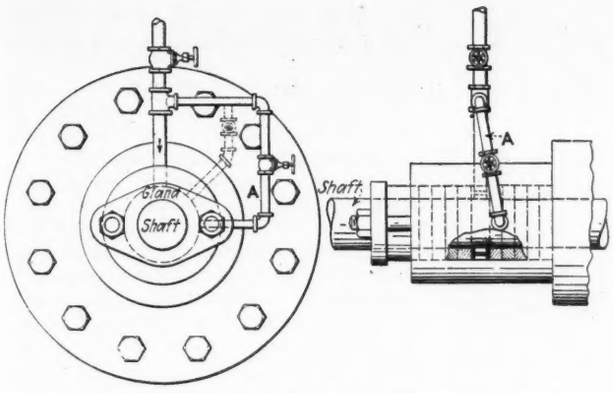
With this layout, each motor may be run alone, and each may be shut down without affecting the other. However, if both motors are required, which is the normal operation, motor No. 2 must be started first.

Winnipeg, Man. R. H. BAKER.

Auxiliary Sealing Line for Pump Stuffing Box

CONSIDERABLE TROUBLE is had in some plants with centrifugal pump packing owing to the water sealing ring or lantern being improperly placed in the stuffing box. When the stuffing box is packed the sealing ring is placed in line with the pipe.

When the packing is drawn up considerably it is obviously impossible to draw up from both ends toward



Arrangement of auxiliary sealing line to stuffing box

the center, hence the ring may be pushed in past the sealing water entrance and the adjacent ring of packing takes the former position of the water ring. Water will now be shut off and the packing will immediately heat up, assuming a high-speed pump. If there is less than atmospheric pressure inside the pump at the bottom of the stuffing box the pump will probably take in air. If there is high-temperature, high-pressure water in it, it will tend to overheat the packing and it will last but a short time.

To prevent this, a hole may be drilled and tapped through the side of the stuffing box on a horizontal axis, as shown at *A*. Where the construction of the pump does not permit putting the connection on the horizontal it may be placed at 45 deg. as shown by the dotted lines. The hole is centered approximately three-quarters the width of the water ring toward the inner end of the stuffing box. The auxiliary line is connected as shown in the illustration.

With this arrangement the valve in the auxiliary sealing line can be opened at such time that the water ring may be pushed past its normal position and the ring will still have a supply of water. H. M. Spring.

Milford, N. J.

Turbine Drives for Auxiliaries

I was much surprised to read the editorial "Steam-Driven Auxiliaries" in *Power,* Nov. 3. The idea of using efficient steam auxiliaries is not new; in fact, engineers and manufacturers have been constantly at this problem for many years and consideration of steam drive has come up in the design of almost every central station.

It is true that the early turbine drives were very wasteful in their consumption of steam. This was due principally to the fact that the units were direct-driven and a compromise had to be made between the speed of the turbine and the speed of a pump or blower. The efficient speed of the turbine was much too high for the efficient speed of the driven unit and the result was that the speed adopted was not economical either for the turbine or the driven equipment.

The first radical improvement came in the use of a reduction gear. This materially increased the efficiency of the unit, as it was possible to use a high speed for the turbine and a low speed for the fan or pump. However, many troubles arose, in some cases due to the use of too high a gear ratio, and also due to noisy operation. These troubles were gradually conquered, and for some years it has been possible to obtain satisfactory turbine drives which are very economical.

Whether motor drive or steam drive should be used is a problem which must be settled for each installation. The determination is governed largely by the conditions under which the plant must operate, such as load factor, degree of reliability to be obtained on the system, whether the system is an alternating-current or a direct-current network, relative cost of installation in each case, and also whether the plant is to be operated mostly as a stand-by.

The writer has had supervision of the design of many plants and in some cases motor drive has been the logical solution, whereas in other cases turbine drive has proved more economical, taking into account operating and fixed charges.

For instance, at the Hell Gate station the auxiliaries are in nearly every case driven by motors, whereas at East River station in New York all essential auxiliaries are driven by turbines. In each case it was a matter of determining the total yearly costs for various systems, namely, turbine drive, alternating-current auxiliaries and direct-current auxiliaries.

At the East River station the electric auxiliaries figured to be slightly more efficient on the entire station, but the cost of installation of motor-driven auxiliaries which would safeguard the Edison direct-current system was so much in excess of the steam-driven auxiliaries that the net result was in favor of installing steam drive.

Because a steam auxiliary is highly efficient it does not follow that it should be used. A complete analysis of the heat balance with the various systems and complete estimates must be made before it can be determined that one of the three systems, namely, steam, direct-current or alternating-current auxiliaries, is the most economical, taking into account all costs.

Figuring a heat balance for a modern central station is a long,t edious job, because all sorts of assumptions must be made, which may be entirely upset before the job is finished. There are so many variables involved that it is only after a long study of the problem that any solution can be reached. It was formerly a simple problem, but has today resulted in probably the most extensive calculations involved in the design of a central station. As a matter of fact, how many of us ever heard of the heat balance of a station until a few years ago?

New York City. John H. Lawrence,
President, Thos. E. Murray, Inc.

Correcting Centrifugal Pump Difficulty

In some types of centrifugal pumps the stuffing box embodies the use of a lantern or water seal. With this design, pieces of packing, dirt and sediment gradually collect in the water sealing ring or lantern, settling at the bottom and in time may completely fill it up. When this occurs the inlet of the water sealing line is invariably stopped up. This results in the packing running dry. The pump may take air in through the packing or may cause overheating and possibly burn out the packing in the case of a high-speed shaft.

By drilling and tapping a hole in the bottom of the stuffing box directly under the sealing water line and adding a valve this trouble can be eliminated. Once every few weeks of operation this valve should be opened for several minutes and the ring flushed.

READERS' PROBLEMS

Conducted by L. H. MORRISON

SURFACE TENSION—*What is the meaning of "surface tension" as applied to a liquid? This was asked in an examination for mechanical engineers and I failed to answer it.* C.R.M.

This question, apparently one confusing to many engineers, was answered in *Power*, Nov. 11, 1930, as well as in several mail replies.

Surface tension is that characteristic of a liquid that causes it to act as if a tight membrance had been drawn across the surface, resisting, to some degree, the breaking of the surface. The phenomenon is due to the mutual attraction of the molecules of the liquid.

Within the body of the liquid the molecules exert attraction on each other, so that a single molecule is attracted on all sides by other molecules, or the net force causing a molecule to move becomes zero. But the molecule at the surface is not attracted by any molecule above it, so that there is a net force causing it to move downward toward the molecules immediately below it. As a result the top surface is more dense, and a steel needle will float on it if carefully deposited.

It is surface tension that causes a drop of water or oil to assume a spherical or spheroidal shape. This is because the internal attraction of the molecule tends to draw the liquid into the smallest possible volume, which is a sphere. The weight of the drop, however, causes the drop to flatten to a spheroid.

Surface tension may cause foaming in a boiler. If an impurity is added that increases surface tension, before a steam bubble moving upward toward the water surface is able to pierce this surface the steam pressure within the bubble must be higher than the pressure in the steam space. It then causes the water surface to rise, and when the bubble pierces the surface it immediately explodes, due to its greater interior pressure, carrying up with it some water. If the action is vigorous enough the steam space will be filled with the mixture of water and steam. This action is heightened by the fact that each steam bubble is surrounded by a film of water having a surface tension sufficient to cause the bubble to maintain its form until it enters the steam space. Strangely, an impurity that settles on the surface reduces the surface tension, while others, like salt, will be taken up by the body of the water and increase the tension.

LEAKS IN RUBBER TUBING—*In certain tests we are conducting rubber tubing is employed to pass gas into a receiver. We find that the gas escapes through the pores of the rubber. Can this be corrected?* G.M.

If the tubing is soaked for 24 hr. in glycerine the pores will close up.

CONSERVATION OF ENERGY—*A flat or ribbon spring is to be tightly wound, requiring the expenditure of 100 ft.-lb. of energy in the winding. The wound spring is to be inserted in an acidproof case which is to be an exact fit, leaving no room for the spring to unwind. The case is provided with a minute hole for introduction of acid. Theoretically, the spring is to be destroyed with acid instantaneously. What becomes of the 100 ft.-lb. of energy stored in the spring? At first this proposition seemed rather foolish, but it was propounded by a student of physics and the more I have thought of it the more it intrigues me.* E. C. MC C.

In doing work such as the tightening of a spring the heat equivalent of the mechanical work done reappears as heat. A common example of this is the way a block of iron is heated if it be hammered. In the case of the coil spring of the question, the 100 ft.-lb. of work reappears as heat and the temperature of the spring increases. Let it be assumed that the spring weighs 1 lb., then as the heat equivalent of 100 ft.-lb. of work is $\frac{100}{778}$ B.t.u., the 1-lb. spring will have a temperature rise found from the formula

$$Q = MCt$$

When Q = Heat available = $\frac{100}{778}$ B.t.u.

M = Weight = 1 lb.

C = Specific heat = 0.11 for steel.

t = Temperature rise.

Substituting the volumes given

$$\frac{100}{778} = 1 \times 0.11 \times t$$

t = 1.2 deg. F. (approximately).

If the spring does not cool before it is consumed by the acid, the heat equivalent of the 100 ft.-lb. of work, that is, 0.13 B.t.u., will cause the entire acid solution to be warmer.

Ordinarily it is to be expected that the spring will cool off, in which event the heat equivalent of the work done warms the atmosphere.

Continuing the spring action, it is well to point out that if the spring instead of being eaten by acid is allowed to uncoil after it has cooled back to its original temperature, mechanical work equal to approximately 100 ft.-lb. will be done. But the spring will cool off while uncoiling, since the mechanical work is done at the expense of the heat content. It is obvious that the law of the conservation of energy is still intact.

A Question for Our Readers

IN A DIESEL PLANT of 2,250 kw. with an annual capacity factor of 71 per cent would there be an actual saving if boiler oil costing 3.25c. a gallon was used in place of 30 Baumé oil costing 5.2? Would this change entail the use of a light oil when an engine is started? To what viscosity should the oil be heated? T.W.

Suitable answers from readers, if received promptly, will be paid for when published.

SPECIFIC HEAT RATIO FOR HELIUM—*In calculating the work of compression for helium, my superior uses a value of n, the ratio of specific heats of 1.67. Is this correct and why does it differ from n for air, namely 1.408.* V.M.R.

All monatomic gases, including helium and mercury vapor, have the value of $n = 1.67$. The reason why this is different from other gases, which mainly have a value of $n = 1.408$, is difficult to explain without going deeply into higher physics.

Briefly, the total energy in a molecule is proportional to the degrees of freedom, that is, the number of coordinates necessary to determine its exact location. The position of a point in space can only be determined when the values of three ordinates are known. If the total number of degrees of freedom is X, it can be shown that the ratio of the specific heats is given by the expression $n = 1 + \frac{2}{X}$. It follows, then, that since helium has a value of $n = 1.67$, by placing the value in the expression, $1.67 = 1 + \frac{2}{X}$, we find that $X = 3$, that is, a helium molecule has three degrees of freedom and acts as a point. On the other hand, hydrogen, oxygen and other gases, with a value of $n = 1.408$ have five degrees of freedom, experiencing not only translation but also rotation.

STEAM AND AIR SOOT BLOWERS—*Our steam pressure is 250 lb. and we have a 90-lb. air supply of sufficient volume for the purpose. If steam costs 27c. per 1,000 lb. and 90-lb. air costs 3c. per 1,000 cu.ft. of free air, what would be the relative advantage of each medium for soot blowing when comparing cost, effectiveness and maintenance?* L.G.G.

The maintenance of the two types should not be radically different. But since the effectiveness of the blow depends upon the velocity of the fluid stream, steam should work out better, since its velocity leaving the nozzle would be much greater than that of the air, due to the greater pressure drop.

After expansion to atmospheric pressure a pound of the steam would have a volume of approximately 31 cu.ft., the cost of 1,000 cu.ft. would be $\frac{27}{31}$ = 0.87c. Consequently, the steam would be cheaper for approximate equal final volume. Erosion might be less with air, but this difference is unknown.

Relative Merits of Dry Vacuum Pumps and Steam Air Ejectors

THE QUESTION

WE ARE USING rotative dry vacuum pumps on the condensers of our 2,500-kw. turbines. The best vacuum we can pull is 27 in. even though our cooling water is ample. Our manager suggests that steam air ejectors would be better. What are the experiences of Power's readers as to the relative merits of the two appliances as vacuum producers, and relative operating costs? A.C.B.

IT WOULD BE poor policy to discard the rotary dry vacuum pumps for no other reason than that a low vacuum exists. This statement is made with the provision that the vacuum pumps are of the correct capacity and in fair condition. It seems likely from what data are given and assuming that a higher vacuum was previously maintained that the trouble lies along other lines than that vacuum pumps are used instead of steam jets. Performance of a dry vacuum pump depends to a great extent on the vapor temperature at its suction. For example, if this temperature is reduced from 82 to 79 deg. F. the size of the pump required will be cut in half. If an additional 7 deg. reduction is made a pump of one-fourth the size will be sufficient. Sometimes a small stream of cold water is sprayed into the suction when an air cooler is not provided. This water enters through an orifice and helps to seal the piston, reduce the pressure on the vapor and lower the vapor temperature.

It is stated that there is ample cooling water. But what is the condition of the condenser tubes? A careful check for air leaks at the atmospheric valve and other such likely places should be made. If a record of the condenser performance curves has been kept these should be examined for indication of possible condenser difficulty. Another possibility that should not be overlooked is an increase in the water rate of the condenser. If steam-flow meters to the turbines or feed-water meters are not used or records not kept, the condenser may be operating at considerably over its rated capacity without the engineer's knowledge.

First cost, small space requirements, low maintenance and ability to return heat to the feed water are important factors leading to the increased use of steam air ejectors. If the vacuum pumps are in poor condition it will probably pay to make this change, but other sources of trouble should be carefully checked first. H. M. SPRING.

Milford, N. J.

FOR THE past six and one-half years we have had the two types of condenser-air equipment in service in our engine room. We have two sets of steam air ejectors serving two surface condensers and four rotative dry vacuum pumps serving six barometric condensers.

The rotative pumps have served long and faithfully (the oldest was installed in 1906), but the steam air ejectors are definitely the most satisfactory in every respect.

The steam air ejectors are the simpler to operate, requiring practically no attention other than cleaning the strainer screens at infrequent intervals. Without a moving part and with no oiling or adjustments of any kind, there is nothing to cause a service interruption. We have found them reliable and economical in steam consumption. The nozzles show no appreciable wear, and as they operate at a constant pressure the steam consumption does not change. These units take up very little space and can be installed in most any out of the way place. Quietness of operation is another attractive feature.

The rotative dry vacuum pump is a machine of many parts, and therefore a certain amount of attention must be given it. The bearings and other moving parts, as well as the cylinders, require lubrication. Adjustments must be made and valves kept tight to maintain efficiency. No matter how much supervision they are given, a part may fail or a valve stick open, causing a service interruption.

The first cost of a steam-jet air ejector is less than that of any other type and the installation is less costly. As to relative operating costs, we have only the manufacturer's guarantee, which at the time of purchasing was not to exceed 180 lb. steam per hour for the steam air ejector and 195 lb. for the rotative dry vacuum pump.

ELMER N. ANDERSON.

Austin, Minn.

THE ROTATIVE air pump that A. C. B. writes of is evidently not in proper working condition if the maximum vacuum obtainable is 27 in. Such a pump in good repair should give a vacuum that approaches closely the theoretical for the cooling-water temperature. It would be prudent for A. C. B. to check the tightness of the air pump lines and also to make sure that the pump clearances are right. If the condenser itself is in bad shape a high air leakage may make the capacity of his pump insufficient to handle the large quantity of air at a good vacuum.

A single-stage steam-jet pump will require more steam than a rotating pump to produce a given vacuum, whereas the steam consumption of a two- or three-stage jet pump will be less than that of the dry vacuum pump.

If a vacuum of 28.5 to 29 in. is desired it would be not advisable to use a single-stage jet pump, since its efficiency would be considerably reduced at such a high vacuum. A two-stage jet pump would give a higher vacuum for the same steam consumption.

Taking everything into consideration, it seems to me that a two-stage steam jet air pump is a better and more economical piece of apparatus than a rotative air pump, since it is more efficient, requires less maintenance and gives a higher vacuum for the same steam consumption. GORDON R. HAHN.

Astoria, N. Y.

TESTS were run in one of our plants on three types of apparatus used to produce vacuum, these being a reciprocating pump, a rotary pump and a steam jet. These types are in constant use producing vacuum for different conditions and degrees. The object of our investigation was to determine the cost of producing vacuum by the three methods and to reduce these findings to a comparative basis.

The performance curves showed that the power costs of all three types changed materially around 20 in. of vacuum. Above this point there is a marked increase in the power consumption per pound of air moved in the case of both the reciprocating pump and the rotary pump. The steam jet showed a much more nearly straight line or a much more gradual curve. These curves indicated that there may be a place in one plant for all three types of vacuum pumps.

From the power consumption at high vacuum, it would appear that steam jets would be the cheapest, and if that is the only consideration they should be chosen. This type has given highest vacuum with a reasonable cooling surface. The efficiency of a surface condenser is determined by the removal of the air and condensate. The steam jet seems admirably adapted to the complete removal of both air and moisture. Our experience indicates the steam jet the more satisfactory type to use for turbine-condenser work.

JOHN P. SIMONS,
Plant Engineer,
Industrial Rayon Corp.

Cleveland, Ohio.

A VACUUM of 27 in. referred to a 30-in. barometer could most decidedly be improved. However, the questioner may live at an altitude where the barometer reads 27.5 in., in which event he would then have a very good vacuum.

The following are a few points of merit in favor of steam air ejectors: lower steam consumption; extreme simplicity; no moving parts; no lubrication; minimum space; minimum weight; no foundation required; noiseless operation; no attention required during operation; quick starting; continuous service; reliability in operation; small initial cost and maintenance cost practically nil.

JOHN VAN MAARION.

Lethbridge, Alta., Canada

WHAT'S NEW IN PLANT EQUIPMENT

Improved Multiple-Retort Underfeed Stoker

GREATER SIMPLICITY with increased strength, resulting in lower power consumption and reduced maintenance, are claimed for the new Riley Model R underfeed multiple-retort stoker brought out recently by the Riley Stoker Corporation, Worcester, Mass.

In the new design the principle of distributing and breaking up the fuel bed by means of reciprocating retort sides, a distinctive Riley feature, is retained. An important feature of the new stoker is the design of the substructure or frame on which the stoker is built. The front unit, comprising the coal-feeding mechanism, retains the truss-like construction in which three heavy angles tie together the cylinders and crankshaft brackets. In addition there has been added a channel which ties into the front structure and provides support for one end of the longitudinal structural members, the other ends of which rest in shoes that are free to slide on the baseplate, thus taking care of expansion.

Another important change is the method of mounting the side bars. They now rest at the front and rear ends on self-aligning shoes. On the longer stokers, in which the side bars are of two pieces, the center joints are supported on other self-aligning shoes, which rest on wing-like extensions of the longitudinal members of the substructure. No cross girder is required to support the center, as in the older design.

The retort bottoms rest directly on the substructure and the weight of coal on the retort is thus transmitted directly to the substructure. The side bars, being entirely carried on the self-aligning shoes, exert no load on the sidebar rods, these rods now serving to transmit motion only.

The stoker front is changed in several details, but principally in the gear boxes. The new gear box retains the double-reduction worm-drive using cut worms of hardened and polished alloy steel. It has two speeds and a neutral position, the change in speed being obtained by means of a planetary clutch. The drive shaft is placed above the oil level to prevent leakage and obviate packing troubles. Both worm shafts are equipped with roller bearings.

In the new design of coal hopper each cylinder has its hopper connection provided with an inspection opening and a shut-off slide so that coal may be cut off from any one cylinder in case of a stoppage which does not readily clear itself. Each of these hopper connections may be removed without disturbing the others, providing easy access in removing obstructions. The hopper itself is designed to meet the requirements of each individual installation and is equipped with an agitator to insure positive coal feed. The agitator is driven through a link mechanism from one end of the crankshaft.

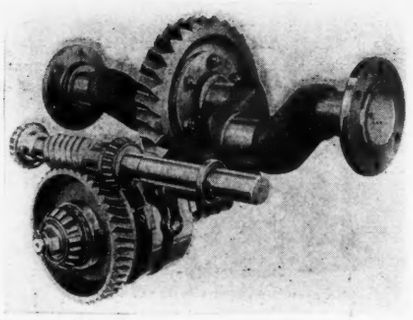


Fig. 4—Assembly of reduction gearing used in stoker drive

As mentioned previously the sidebar rods which impart motion to the moving tuyères now carry no load of the furnace parts. Their design has been further modified by making their connection to the coal-feeding mechanism of flexible construction. Also, the wrist pins, which project from the coal-feeding plunger and actuate the side bar rods, instead of being in two pieces as formerly, are now in one piece, making a rigid construction and reducing the stress on the plunger. The shearing pin in the connecting rod is retained.

The rear of the stoker is also changed somewhat in construction. The overfeed grates are now provided with dampers that are positive in their action, placing this portion of the grate surface under definite control of the operators.

The dump plates are still of the rocker-plate type. They have been increased in strength and are now supported by a linkage. They are operated either through a reducing gear or, where desirable, through a steam or hydraulic cylinder. Flat dump plates can be furnished when desired, and on larger units clinker grinders, either of the single- or double-roll type, may be supplied.

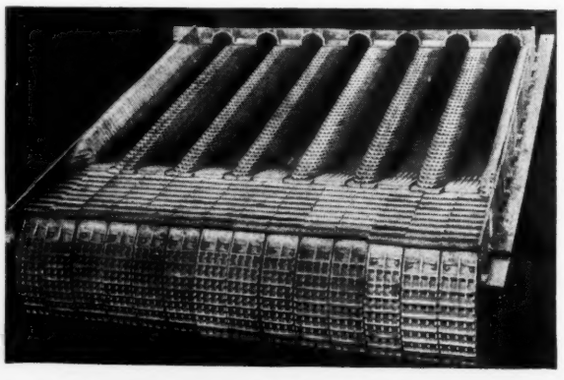
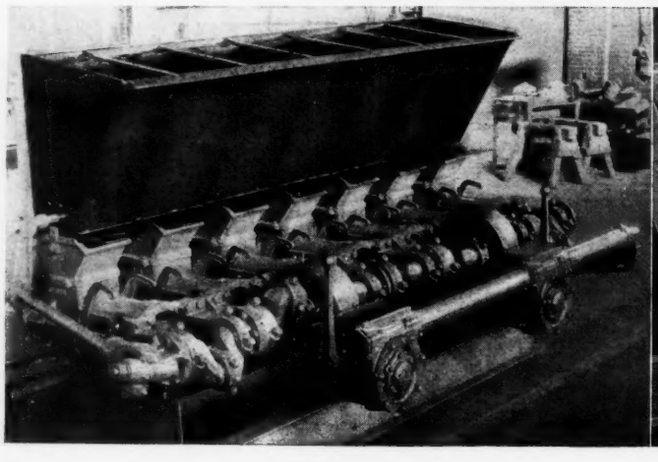
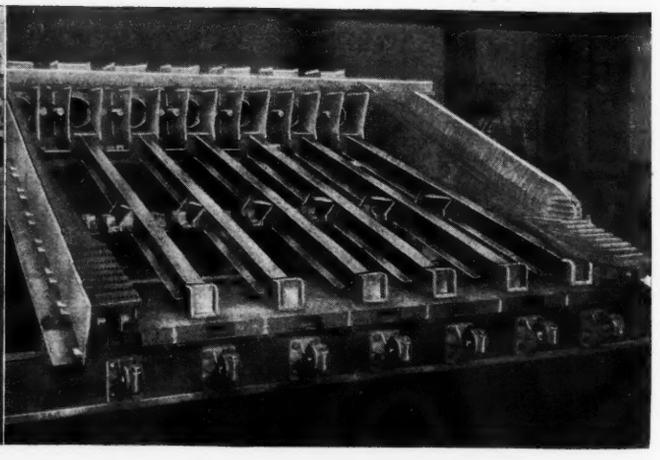


Fig. 1 (Right)—Furnace view of Riley Model R seven-retort stoker

Fig. 2 (Below, Left)—Front view of stoker, showing crankshaft and gear box assembly

Fig. 3 (Below, Right)—Improved designs of substructure requires no central support





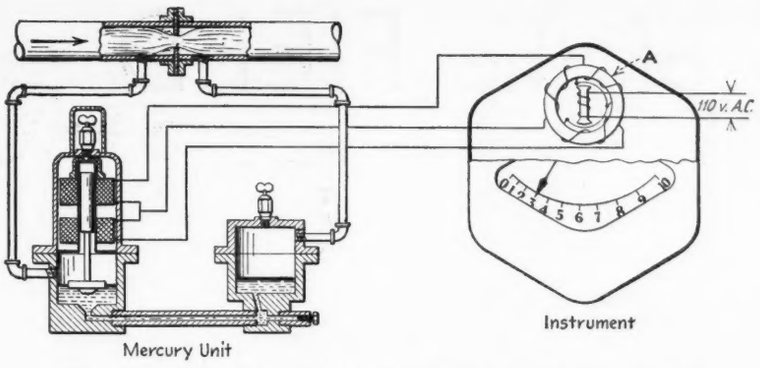


Fig. 1—General arrangement of instruments and interconnections shown diagrammatically

Electrically Operated Oriflo Meter

AN IMPROVED form of the self-balancing inductance bridge in which a self-synchronizing motor replaces the secondary coils, actuates the Type EB oriflo meter developed by Builders Iron Foundry, Providence, R. I. The principle employed depends for its operation upon the electrical balancing of two similar circuits.

Referring to Fig. 1, which shows the instrument and power unit diagrammatically, any changes in the rate of flow cause the rise or fall of the mercury and a corresponding movement of the float in the pressure element. At each movement of the float an attached core moves within the divided primary coils, which are connected to a source of alternating current. The movement of the core within the coils unbalances the circuit and causes the rotor of the self-synchronizing motor *A* to take a position that will again balance the circuit. With each movement of the rotor the indicator hand or chart pen takes a new position indicating the rate of flow.

In the mercury unit, which is designed for a pressure of 900 lb. gage, the electrical circuit is completely isolated from the mercury as well as from the fluid metered by means of a non-inductive sleeve, the extended flange of which is clamped between the flanged connection of the body. Two cone check valves prevent loss of mercury due to sudden surges in pressure.

The hexagonal type of case is used with a view to condensing panel space where several instruments are to be grouped together. The flow indicator has an illuminated scale 8 in. long with black graduations. The instrument is suitable for use on steam, air, gas, water and oil.

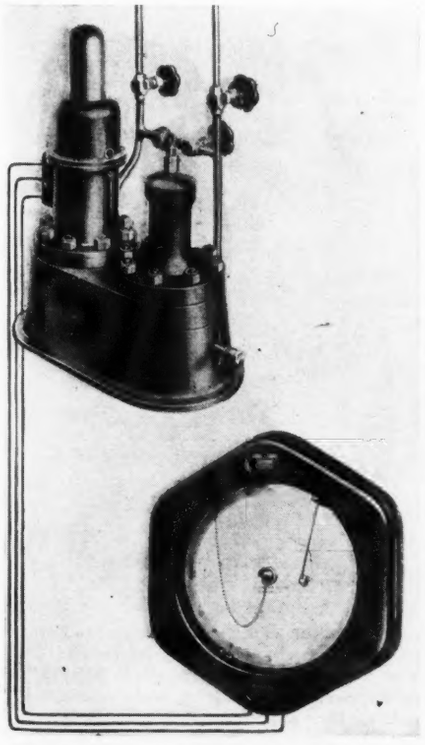


Fig. 2—Mercury unit with register-recorder

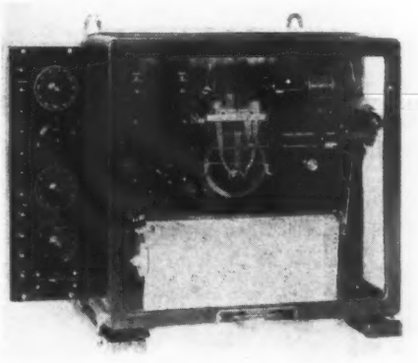
Automatic Recorder for Condenser Leakage

THE RECORDER illustrated, put out by Leeds & Northrup Company, 4901 Stanton Ave., Philadelphia, Pa., is designed to furnish a continuous record of the amount of leakage of impure cooling water into the relatively pure water in the hotwell of a surface condenser. Reading directly in per cent of leakage, its records furnish notification of undesirable leaks in the condenser equipment.

The electrolytic conductance method employed depends for its operation on the fact that salts in solution in water are ionized to a greater or lesser extent and therefore the solution becomes electrically conducting to a greater or lesser degree, depending on the salt concentration and the degree of ionization. For all boiler and cooling waters the solutions are so dilute that the salts may be considered as 100 per cent ionized; then it is evident that the electrical conductance of the solution becomes directly dependent on the salt concentration.

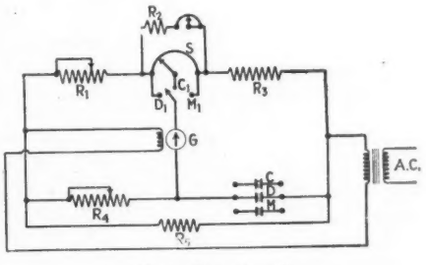
The recorder circuit shown by the diagram consists of a balanced Wheatstone bridge operated from alternating current, according to the method usually employed for electrolytic conductivity measurements. R_2 is the slide wire of the conventional type of self-balancing recorder and *G* is the galvanometer, with its alternating-current field. The whole instrument is supplied with current from any convenient alternating current power source.

Three conductivity cells are used: *C*, which measures the conductance of the condensate in the hotwell; *D*, which measures the conductance of the distillate or condensed steam taken from the turbine with no opportunity for condenser leakage; and *M*, which measures the conductance of an artificially prepared mixture of distillate and cooling water. These cells are connected to a switch as shown on the left of the recorder so that any one of them can be connected into the bridge circuit by proper setting of the switch. Normally, cell *C* is connected to the bridge, so that the recorder draws a record representative of the conductance of hotwell condensate or condenser leakage. Resistance R_4 is designed to be set for any desired temperature, to compensate for the temperature of the solution whose conductance is being measured.



Per cent leakage recorder

The conductivity cells used are of the usual type, consisting of metal electrodes of definite area spaced a fixed distance apart. Cell *C* is of the pipe type, designed for screwing into some convenient hotwell connection, while cells *D* and *M* are of a smaller type, designed for immersion in glass vessels. The recorder can be modified to permit the sounding of an alarm bell when the leakage exceeds a prescribed limit.



Recorder circuit

▼

MOISTURE-PROOF gasket material, known as "1000 Compound," has been developed by the General Electric Company especially for applications where the primary purpose of a gasket is to exclude moisture. It is a white, odorless, sulphur-free rubber compound, available both in sheets and moulded shapes. It is also said to be highly oil-resistant.

NEWS of the FIELD

Live Program Announced for Annual Meetings of A.S.H.V.E. and A.S.R.E. in Cleveland, Jan. 25-29

ENGINEERS from all parts of the country will gather in Cleveland, Ohio, during the week of Jan. 25, 1932, to attend the 38th annual meeting of the American Society of Heating and Ventilating Engineers, the 27th annual meeting of the American Society of Refrigerating Engineers and the Second International Heating and Ventilating Exposition.

Headquarters for the A.S.H.V.E. has been established at the Hotel Statler and registration will begin on Monday, Jan. 25. Convention headquarters for the A.S.R.E. will be at the Hotel Cleveland and registration will commence on Tuesday. The exhibitors will maintain headquarters at the Hotel Hollenden, convenient to the exhibits in the Cleveland Auditorium.

Two joint sessions have been provided for the members of the A.S.H.V.E. and A.S.R.E., and will be held on Wednesday and Thursday mornings respectively in the Little Theatre of the Cleveland Auditorium. All other sessions of the societies will be held at their respective hotel headquarters.

Technical sessions of the A.S.H.V.E. will begin on Tuesday and among the important subjects to be discussed are heat transmission, hot water and steam heating, combustion, oil burning, heating by radiation and ventilation. Refrigeration in public health, machinery for industrial applications and problems of the commercial-domestic refrigeration field will be covered by papers presented at sessions of the A.S.R.E., while new air-conditioning systems will receive attention at the joint gatherings.

Besides the reports of committees on research, testing and rating unit ventilators, and ventilation standards, the following papers will be given by A.S.H.V.E. members: "Importance of Radiation in Heat Transfer Through Air Spaces," E. R. Queer; "Heat Emission From Iron and Copper Pipe," F. C. Houghten and Carl Gutberlet; "Hot-Water Friction Heads in One-Inch Cast-Iron Tees," F. E. Giesecke and W. H. Badgett; "Some Fundamental Considerations of Corrosion in Steam and Condensate Lines," R. E. Hall and A. R. Mumford; "Changes in Ionic Content of Air in Occupied Rooms Ventilated by Natural and by Mechanical Means," C. P. Yaglou, L. C. Benjamin and S. P. Choate; "Heat Transmission as Influenced by Heat Capacity and Solar Radiation," F. C. Houghten, J. L. Blackshaw and E. M. Pugh; "Field Studies of Office Building Cooling," S. S. Sanford, E. P. Wells and J. H. Walker; "A Study of Intermittent Operation of Oil Burners," L. E. Seeley; "Room Warming by Radiation," A. H. Barker; "A Study of the Combustible Nature of Solid Fuels," R. V. Frost; and "Surface Coefficients as Affected by Direction of the Wind," F. B. Rowley and W. A. Eckley.

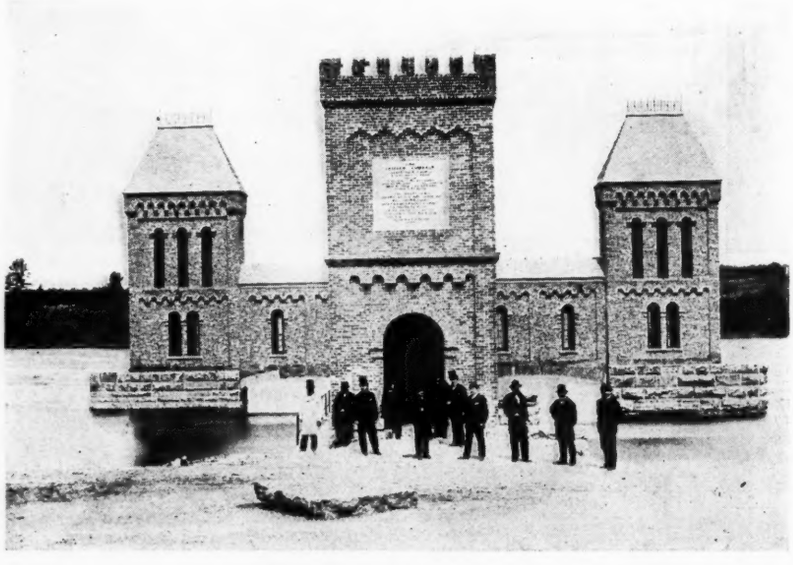
Papers to be presented by the A.S.R.E. include: "Two-Speed Synchronous Motors for Compressors," R. C. Allen; "Gas Engines for Ammonia Compressors," F. W. Laverty; "Study of Oil-Engine Compressor Costs," C. R. Neeson; "Application of Electric Refrigeration to the Heating and Cooling of Houses," F. H. Faust, E. W. Roessler and A. R. Stevenson, Jr.; "Air Conditioning Applied to Cold Storage, Including a New Pyschrometric Chart," C. A. Bulkley; "Biological Aspects of Thermal Engineering," S. R. Prescott; "Review of Refrigeration and Food Practice in Europe," A. W. Ewell; "Refrigerator Car Surface Temperatures," W. J. Hukill; "Ice for Air Conditioning—A Survey and a Forecast," R. T. Brizzolara; "Properties and Use of Metal Foil Insulation," J. L. Gregg; "What Happens in the Evaporator?" L. A. Philipp; and "The Refrigerating Machine as a Production Problem," Edward Hughes.

Welding Explosion Injures Nine at Gatineau Plant

NINE EMPLOYEES of the Gatineau Power Company's plant at Farmers, on the Gatineau River, Ont., were severely burned on the afternoon of Dec. 18, when an acetylene drum at the west end of the power house exploded. More than 4,000 window panes were shattered, the frame iron-work of the windows twisted and ripped from their settings in the solid concrete walls, several small partitions were blown down in a mass of wreckage and steel platforms on the galleries wrenched from their bases. Damage to the power

▼ ▼ ▼

COHOES PLANT 100 YEARS OLD



This year marks the 100th anniversary of the completion of the first dam across the Mohawk River at Cohoes, N. Y., to supply cheap hydraulic power to industrial plants. Starting in 1831 the demand increased so rapidly it was necessary to enlarge the system several times, and in 1866 a new stone dam, 1,443 ft. long, and gatehouse (shown in the illustration) were constructed. Since then a modern 54,000-hp. hydroelectric station has been erected and the original Cohoes Company has become a part of the Niagara Hudson Power System

house is estimated at more than $15,000. The exact cause of the accident was attributed by officials to the catching on fire of the hose attached to the acetylene tank. Members of the repair crew were engaged in a welding operation at the west end of the generator floor when sparks from the white hot steel ate through the hose line, below where it connected with the oxygen stream, igniting the highly explosive acetylene gas, which was under 400 lb. pressure.

The explosion tripped the generators off the system, and they were not started again until after a careful examination had been made. As Farmers is linked up with the Chelsea, Paugan and Bryson plants of the Gatineau Power Company this temporary closing off of power at Farmers had little material effect on the points to which electrical energy is distributed.

Rutgers Enlarges Research Program to Aid Unemployed

A PLAN to provide employment for engineers by increasing research activities has just been adopted by P. H. Daggett, dean of the College of Engineering at Rutgers University. Six special research assistants will be appointed for the spring term, Dean Daggett announced. These assistantships will carry a stipend of $150 and exemption from all tuition fees.

Four of the assistants will be used in part-time work on the following projects: 1. Study of the velocity of flow and sedimentation in tanks; 2. Study of New Jersey sands for building purposes; 3. Study of slag as a material for sprinkling filters; 4. Breakdown law for rubber insulated wires. The other two assistants will be assigned to problems to be chosen by the applicants.

Applicants for appointment must be graduates of recognized colleges of engineering and must present a certificate from the New Jersey State Committee of American Engineering Council that they are worthy of assistance in this emergency.

Materials Handling Body Formed by Manufacturers

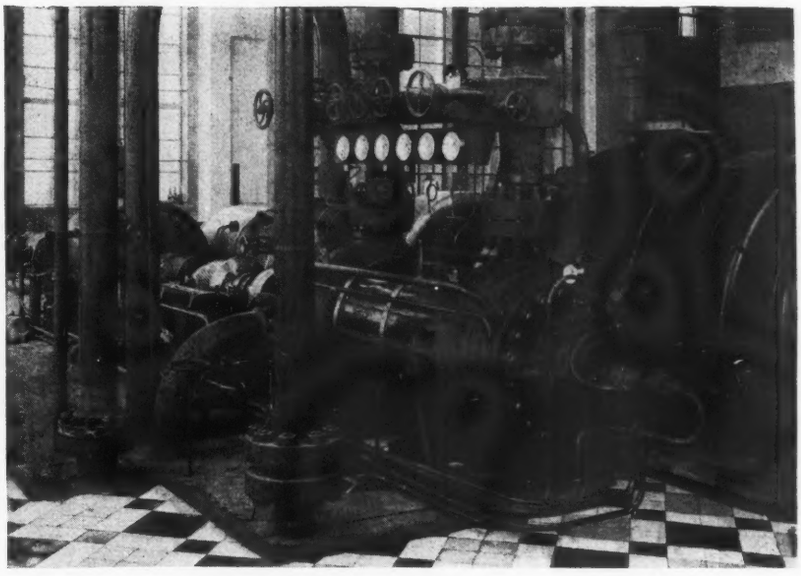
MORE THAN 70 representatives of materials handling equipment makers attended a meeting in Cleveland recently, at which an organization to be known as the Materials Handling Institute was formed. The primary object of the new body will be educational, along with the promotion of cooperation among the various groups of manufacturers.

Officers chosen are: F. E. Moore, Mathews Conveyor Company, president; J. B. Webb, Jervis B. Webb Company, vice-president; H. W. Standert, Northern Engineering Works, treasurer; and J. A. Cronin, Materials Handling & Distribution Company, secretary.

A board of governors was elected composed of one representative from each of the following groups of manufacturers: Hoists and cranes, conveyors, trucks and mechanical transmission. The board was given authority to add to its representation as it sees fit after making a study of the industry branches in more detail.

The meeting adjourned to the week of May 2 to 6, 1932, during which the American Foundrymen's Association will hold its annual meeting in Philadelphia.

2,500-HP. CENTRIFUGAL BOILER FEED PUMP



The largest centrifugal boiler feed pump made by Sulzer Bros., was recently installed in the Langerbrugge power station in Belgium. Rated at 2,500 hp., it delivers 298,000 lb. of water per hour at a working pressure of 362 lb. per sq.in. and a temperature of 356 degrees Fahrenheit

▼ ▼ ▼

Syracuse Co. Contracts For Natural Gas Supply

SYRACUSE LIGHTING COMPANY, a subsidary of the Niagara Hudson Power Corporation, has contracted to purchase natural gas from the Standard Oil Company of New Jersey and the Columbia Gas & Electric interests, represented by the Lycoming United Natural Gas Corporations. Negotiations have been practically completed and the matter will be submitted in the near future to the New York Public Service Commission for its approval.

A reduction in gas rates to users in Syracuse is expected to result from the use of the cheaper, richer natural gas, and engineers are working on a new rate schedule. Meanwhile, the New York Gas Corporation, subsidiary of the Lycoming corporation, is constructing a 20-in. pipe line from the Tioga gas fields to Syracuse.

National Chamber Submits Plan to Help Business

A NATIONAL PROGRAM for business and employment stabilization, was announced Dec. 18 by the Chamber of Commerce of the United States, after receiving the approval of more than two-thirds of its constituent organization through referenda.

Four chief recommendations to promote economic stability were emphasized in the announcement. These call for the setting up by business itself of a national economic council to aid all fields of industry, finance and commerce in their planning; modification of the anti-trust laws to make clear lawfulness of agreements intended to relate production to consumption; relief in emergencies for the natural resource industries, such as coal, oil and lumber, by the creation of a government tribunal which would permit agreements for curtailment of production when in the public interest; and establishment of privately sustained systems of unemployment benefits as well as other similar benefits based upon definite reserves previously established.

Other recommendations included the following:

"Businesses desiring to combine should have the opportunity to ascertain from a suitable government authority whether or not the proposed combination will be in violation of the anti-trust laws.

"For each field of business a representative trade association should perform the functions of an economic council.

"Aided by increased opportunity for

stability of operation, each employer should so plan operations as to assure the greatest possible number of employees there will be work for the greatest possible number of weeks in the year.

"Unemployment, which now exists and may presently recur, should be dealt with upon an individual basis, locally, through organization to that end.

"Needed relief should be provided through private contributions supplemented by state and local governments, and without any federal appropriations for such purposes."

The committee on continuity of business and employment was needed by Henry I. Hariman, vice-chairman of the board of the New England Power Association. The natural resources committee had as its chairman, Matthew S. Sloan, president of the New York Edison Company.

Large Berlin Machine Works Forced to Suspend Payment

THE FIRM of A. Borsig, Ltd., of Berlin-Tegel, Germany, the largest member of the family-owned Borsig Concern, suspended payments Dec. 18, according to a special cable to the New York *Times*. The firm's financial difficulties were said to be the direct result of the failure of several debtors and of substantial losses sustained through the depreciation of foreign currencies, especially in connection with business done in India and Egypt.

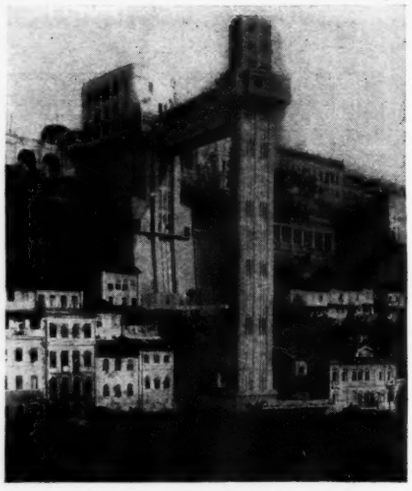
The plant, which is the oldest machine works in Berlin, specializes in boilers, steam engines, compressors and pumps. At present it employs 3,700 workmen, and the orders on hand amount to $3,000,000. Since other plants of the Borsig Concern were not directly affected by the suspension of payments, it is hoped that negotiations with creditors will lead to a settlement that will permit the machine plant to carry on work.

Elevator Tower in Brazil Transports City Population

A VERTICAL TRANSPORTATION PROBLEM involving moving the greater part of a city's population between an upper and a lower level, has recently been solved by the engineers of the Otis Elevator Company.

Bahia, a city in northern Brazil, supplied the problem. With its business center bordering on the bay, and its residential district on the top of a steep incline 195 ft. above, the question of transportation was always a perplexing one to residents, and with the rapid growth in recent years the need for modern transportation facilities became extremely acute. To meet this need, engineers were consulted.

At their suggestion, the monumental La Cerda Tower was built. Made of reinforced concrete, 240 ft. high, this tower is connected with an older and smaller structure by a bridge. In it are housed two large Otis express elevators, comparable with those in the largest skyscrapers.



Recently completed La Cerda elevator tower in Bahia, Brazil

Practically the entire city tried to ride on the new elevators the opening day. Of the 10,000 fortunate enough to do so, many could hardly be induced to leave even after several trips. On the second day the elevators transported more than 24,000 people, each passenger paying 160 reis, or a little less than two cents, a trip.

▼

COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual winter convention in New York City, Jan. 25-29, 1932. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Heating and Ventilating Engineers. Annual meeting and exposition, Hotel Statler, Cleveland, Ohio, Jan. 25-29. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society of Refrigerating Engineers. Joint meeting with the A.S.H.V.E. and annual convention at the Hotel Cleveland, Cleveland, Ohio, Jan. 26-29, 1932. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6, 1932. Secretary, Beekman C. Little, 29 West 39th St., New York City.

National Marine Engineers Beneficial Association. Annual convention at the Hotel Jefferson, St. Louis, Mo., Feb. 8-12. Secretary-Treasurer, Albert L. Jones, 313 Machinists' Building, Washington, D. C.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Edison Writings Displayed At Engineering Library

EARLY WRITINGS of Thomas A. Edison are on exhibition at the Engineering Societies' Library, 29 West 39th Street. The existence of many of the exhibits, prophetic of the inventor's future triumphs, was unknown even to Mrs. Edison, who inspected the display under the guidance of Harrison W. Craver, director of the library.

"Dangers of Electric Lighting," an article by Mr. Edison, which appeared in the *North American Review* of December, 1889, youthful pictures of Mr. Edison, and copies of some of his writings and addresses are shown.

One of Mr. Edison's first phonograph records, a rectangular piece of tinfoil in use in 1878, is displayed. A manuscript written by the inventor in longhand on rough tablet paper contains instructions for the operation of an incandescent lighting system and was "written at the Incandescent Lighting Station of the Edison Illuminating Company of Sunbury, Pa., about midnight, July 8, 1883, by Thomas A. Edison, then electrical engineer of the Thomas A. Edison Construction Company, for those who were to assume the management and operation of small three-wire stations. Of these, Sunbury was first, having been started by Mr. Edison July 4, 1883."

A copy of *Scribner's Monthly* for February, 1880, containing Mr. Edison's endorsement of an article in the publication, is on view. The narrative, by Francis Upton, is referred to by the inventor as the "first correct and authoritative account of my invention of the electric light."

F. H. Martin, Designer of Large Hydro Plants, Dies

Frank H. Martin, hydro-electric engineer who designed some of the largest plants in Canada, died Dec. 17 in Winnipeg, Man. He was 50 years old.

Born at Nanuet, N. Y., Mr. Martin received his education in the public school at Pearl River. After serving an apprenticeship with the Dexter Folder Company, he was employed as a draftsman by various companies in the United States until 1905 when he went to Brazil to take charge of the technical department of the Rio de Janeiro Tramway, Light & Power Company.

For some years after that Mr. Martin was engaged in the design, construction and operation of hydro-electric plants for several Ontario power companies. Later he went to Winnipeg, where he designed the 168,000-hp. Great Falls plant of the Manitoba Power Company. Following this he was appointed chief engineer in charge of design and construction for the Northwestern Power Company, and in that capacity he directed the completion of the initial development at the 225,000-hp. Seven Sisters Falls plant.

Personals

ROY V. WRIGHT, past president of the American Society of Mechanical Engineers and managing editor of *Railway Age,* has been elected vice-president and secretary of the Simmons-Boardman Publishing Company, publishers of *Railway Age* and other transportation magazines. Dr. Wright has been secretary of the company since 1919 and a director since 1915.

BANCROFT GHERARDI, vice-president of the American Telephone & Telegraph Company, was re-elected president of the American Standards Association for the year 1932 at the recent annual meeting of the association. Other officers, who were also re-elected, are: CLOYD M. CHAPMAN, consulting engineer, United Engineers & Constructors, Inc., vice-president and chairman of the A.S.A. Standards Council; and JOHN C. PARKER, Brooklyn Edison Company, vice-chairman of the council.

CAPT. WILLIAM MCGREGOR, vice-president of the Blackstone Valley Gas & Electric Company, Pawtucket, R. I., was recently made a Chevalier in the Legion of Honor in recognition of his services to France during the World War. Captain McGregor has been associated with public utilities in New England for nearly 50 years, and is prominent in the social and civic affairs of his community.

A. S. WILLIAMS, formerly electrical designer with the Northwestern Power Company, is now chief engineer of the company's plant at Seven Sisters Falls. Previous to his connection with the Northwestern company, Mr. Williams was chief operator at the Great Falls generating station of the Manitoba Power Company.

D. S. NICOL, who heretofore has been associated with the engineering firm of Parsons, Klapp, Brinckerhoff & Douglas, Detroit, Mich., recently entered the educational field as professor of electrical engineering at Nova Scotia Technical College, Halifax.

Obituary

FREDERICK SAMUEL JORDAN, sales manager of the nickel department of the International Nickel Company, died at his residence in New York City, Dec. 16 from cerebral hemorrhage. Born in Berea, Ohio, on Aug. 28, 1869, Mr. Jordan began his business career at the age of eighteen when he became a secretary in the Cleveland office of the Big Four railroad. A year later he became private secretary to H. P. McIntosh who was prominent in the Canadian Copper Company. When this company was merged into the organization of the original International Nickel Company in 1902, Mr. Jordan came to New York as sale executive, a position which he held during the progressive development of this company.

How's Business?

PROSPECT of prompt stabilization and progressive strengthening of the domestic financial situation is the most promising spot in the business picture as 1931 passes into oblivion. Financial difficulties growing out of uncontrolled deflation emerged as the most formidable factor frustrating domestic readjustment during the past year. But indications of energetic action on establishment of the Reconstruction Corporation after the congressional recess, intelligent private support of the bond market evidently under way in the interval, and early relief for railroads through rate and wage adjustments, justify expectations of improvement in the domestic picture early next year. Its extent depends upon how promptly and powerfully pressure is applied to reverse deflation and replace and expand credit in use, and how strongly deferred private industrial demand will draw it into employment for replenishment of depleted inventories and improvement and extension of facilities.—*The Business Week*, Dec. 30.

Business Notes

WILSON-MAEULEN COMPANY, New York City, announces that its entire pyrometer and control line will be merged with the thermometer line of the Foxboro Company, Foxboro, Mass. On Jan. 2 Wilson-Maeulen design, production and sales personnel will form the Wilson-Maeulen Pyrometer Division of the Foxboro Company, with headquarters in Foxboro. Charles H. Wilson, president of Wilson-Maeulen, will become associated with the Foxboro Company in the technical and business direction of new division. The company states that the Rockwell hardness tester business will be handled as it always has been, but to avoid confusion the name of the company will be changed to Wilson Mechanical Instrument Company, New York City.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., announces that John Anderson, assistant to J. G. Barry, vice-president, has been appointed secretary of the sales committee. Mr. Anderson succeeds E. G. Waters, who is retiring at his own request on the completion of more than 42 years continuous service with the company, the past 25 being as secretary of the sales committee.

ALLEN-BRADLEY COMPANY, Milwaukee, Wis., announces the appointment of the Petroleum Electric Company as its agent in the Oklahoma territory. The Petroleum Electric Company has its main office at 522 Commercial Building, Tulsa, Okla., and a branch office at 531 West Main St., Oklahoma City.

CATERPILLAR TRACTOR COMPANY, Peoria, Ill., recently appointed J. N. Barnes, C. M. Burdette and F. G. Nunneley assistant sales managers in charge of district representatives and a group of dealers.

CHESTER A. GAUSS, formerly advertising manager of the Fuller Lehigh Company, has opened offices at 11 West 42nd St., New York City, where he will specialize in trade, technical and industrial advertising.

▼

Trade Catalogs

PUMPS—Two illustrated bulletins on centrifugal pumps have just been issued by the Pennsylvania Pump & Compressor Company, Easton, Pa. Bulletin No. 216 covers fully the construction features and specifications of Types OMS and OMSB sleeve and ball bearing multi-stage centrifugal pumps, while Bulletin No. 217 describes Type LS single-stage pumps. The latter publication contains charts and tables for figuring head and output.

VALVES AND FITTINGS—A handy little data booklet on Parker underground water-service fittings has just been issued as Bulletin No. 33 by the Parker Appliance Company, 10320 Berea Road, Cleveland, Ohio. Valves, pipe fittings, tubing and tools are illustrated and described in the booklet.

ELECTRIC MOTORS—"Small Motors" is the subject of Bulletin No. 167 issued recently by the Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo. Fully illustrated, the bulletin is divided into sections describing single-phase, polyphase and direct-current motors in fractional-horsepower ratings.

VALVES—A complete description of the new "Labrotite" gate valve is contained in a 16-page booklet recently issued by the Reading-Pratt & Cady Company, Bridgeport, Conn. Construction features are covered, together with the many applications of the valve.

GENERATORS, TRANSFORMERS, SWITCHES—General Electric Company, Schenectady, N. Y., has just issued the following new bulletins: 1308 on continuous-rated a.c. steam-engine-driven generating sets; 601C on instrument transformers; 1486 on outdoor oil circuit breakers; 1516 on enclosed air circuit breakers; 1442 on dead-front air circuit breakers; 841B on across-the-line starters for induction motors; 1314A on induction time relays; 86B on single-phase directional overcurrent relays; 1497 on terminal boards for small wiring; 1236A and 1242A on "Fabroil" and "Textolite" gears and gear blanks.

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Seal Beach—Los Angeles Gas & Electric Co., South Flower St., Los Angeles, preparing plans for addition to power plant here. Estimated cost $3,500,000. Private plans.

Ga., Augusta—U. S. Veterans Bureau, Washington, D. C., will soon award contract for additional refrigerating and ice making plant here.

Ill., Chicago—Standard Gas & Electric Co., South La Salle St., preliminary construction budget for 1932 as follows: electric department, $16,347,300; gas department, $3,319,809 and other departments including general construction $5,338,857. Total cost $25,015,966. Projects under construction included in above $3,508,034.

Ia., Belle Plaine—City is preparing plans and will receive bids about March 1 for construction of a sewage treatment plant and pumping station. Howard R. Green, 617 First Ave. S. E., Cedar Rapids.

Ia., Council Bluffs—City plans construction of a new pumping plant in event that Missouri River channel is straightened. Estimated cost approximately $450,000. J. C. Jensen, Chn. of Water Board.

Ia., Iowa Falls—Central State Electric Co., Cedar Rapids, plans addition to power plant. Contract awarded for installation of 7,500 kw. steam turbine and auxiliary equipment.

Ia., Milford—City voted $80,000 bonds for construction of a municipal light and power plant, including equipment. Estimated cost $80,000.

Ia., Viscilla—City voted $150,000 bonds for construction of an electric light and power plant.

Mass., Provincetown—Northern Gas Utilities Co., 15 Congress St., Boston, postponed construction of gas plant here. $75,000. G. H. Stevens, 141 Milk St., Boston, is engineer. Maturity indefinite.

Mich., Elk Rapids—City is preparing plans for construction of sewage disposal plant including pump house, pumps, etc. Francis Engineering Co., Saginaw, is engineer.

Minn., Spring Valley—City canceled $25,000 bond election for construction of municipal electric light plant and distribution system. Project postponed indefinitely.

Mo., St. Louis—Board of Public Service, will receive bids in Spring for construction of first unit of Negro City Hospital group to consist of service building, boiler house, laundry building, etc., at Goode, St. Kennerly and Whittier Sts. Estimated cost $350,000. A. Osburg, 301 City Hall, is architect. L. R. Bowen, 301 City Hall, is engineer.

Nev., Boulder City—Six Companies, Inc., c/o E. T. Kibler, Purch. Agt., are receiving bids for electrification of 11 miles of railroad from gravel pit to dam, also twelve cableways and hoists across river of 12 to 20 ton capacity in connection with Hoover Dam project. F. T. Crowe is engineer.

New York—New York State Gas & Electric Corp., Central Ave., Ithaca, has made application to Public Service Commission, for permit to construct a gas plant and distribution system at Freeville, also plant and electric distribution system at Coventry.

N. Y., Dansville—New York State Gas & Electric Corp., has been authorized by Public Service Commission, Albany, to construct gas plant here.

N. Y., Highlands — Central Hudson Gas & Electric Corp., 50 Market St., plans construction of a gas plant and distribution system here.

N. Y., Ossining—Dept. of Correction, State Office Bldg., Albany, received low bids for construction of power house and knit shop, tunnels, heating and electric connections and apparatus at Sing Sing Prison here.

N. Y., Sodus—Lake Ontario Power Corp., preparing preliminary plans for extensions to electric light plant. Estimated cost to exceed $40,000.

N. Y., Stafford—Empire Gas & Electric Co., Geneva, c/o New York Central Electric Corp., 50 Church St., New York, plans construction of a gas plant and distribution system here.

O., Chillicothe—U. S. Veterans Bureau, Washington, D. C., awarded contract for construction of a refrigerating and ice making plant here to York Ice Machinery Corp., 1238 North 44th St., Philadlephia, Pa. $20,656.

Okla., Guthrie—Oklahoma Gas & Electric Co., 321 North Howey St., Oklahoma City, having plans prepared for construction of a new high voltage transformer station here. Estimated cost $25,000. Byllesby Engineering Co., 231 South La Salle St., Chicago, Ill., is engineer. Estimated cost $25,000.

Okla., Hobart—City will soon receive bids for construction of new water supply system including dam, pumping station, pipe line, etc. Estimated cost $250,000.

Pennsylvania—Pennsylvania R.R. Co., Broad St. Station, Philadelphia, awarded contracts in connection with electrifying lines between New York and Washington as follows: to Vare Construction Co., Broad and Vine Sts., Philadelphia: Richmond step-up station at Philadelphia, transmission lines from step-up station to Frankfort Junction and Tacony, installation of through power supply, Shellpot branch, catenary, transmission lines, sub-station foundations, structures and equipment between Wilmington, Del., and Baltimore, Md.; catenary, transmission lines, structures and equipment in connection with additional power supply required for operation of through trains between Trenton, N. J., and Wilmington, Del.; to Arundel Corp., Pier 2, Pratt St., Baltimore, Md., structures, catenary, transmission lines and substations between Baltimore, Md., and Washington, D. C.: to Gibbs & Hill, Inc., Pennsylvania Station, New York, structures, catenary, transmission lines and substations between Trenton and Millstone Junction, N. J., also from Waverly to Greenville. Estimated total cost $6,328,000.

Tenn., Jellico — City plans an election January 2 to vote $150,000 bonds for construction of a light and power plant.

Tex., Wichita Falls — Taxpayers voted to give city authority to establish municipal natural gas plant and distribution lines. Estimated total cost $925,000.

Ont., Cornwell—City awarded contracts for supply of auxiliary and turbine pumps, electrically driven to Babcock-Wilcox and Goldie McCullough, 64 Grand St. S., Galt.

Brazil — Brazilian Government, Sebastiao Sampaio, New York, Consul General, will receive bids until April 30, for electrification of railroad lines around Rio de Janeiro, a part of the system of Central de Brazil Railroad.

Union Socalist, Soviet Republic—Municipality of Kharkov, c/o Amtorg Trading Corp., 261 5th Ave., New York, N. Y., plans construction of civic construction program including 30,000 kw. addition to power plant, civic buildings, etc. in Ukraine Province, here. Estimated cost approximately $31,000,000. Work will be done by technical aid contracts.

Equipment Wanted

Air Compressors—San Diego, Calif.—Bureau of Yards & Docks, Navy Dpt., Washington, D. C., will receive bids until January 6 for air compressors at Naval Operating Base here. Spec. 6650.

Generator Set—Duluth, Minn.—U. S. Engineer Office, will receive bids until January 4 for 1 kw., 115 v., d.c. direct connected steam turbine generator.

Generator Set—Brooklyn, N. Y.—Signal Supply Officer, Army Base, 58th St. and First Ave., will receive bids until January 4 for a three unit motor generator set consisting of d.c. filament and plate current supply generators, a.c. driving motor.

Generator, Condenser, Boilers, etc.—Piqua, O.—City will receive bids until January 6 for turbine generator, surface condenser and steam generating unit, including boilers, exhaust fans, motors, Diesel engine, etc., for proposed power plant. $810,000.

Generator and Switchboard—Two Rivers, Wis.—City, E. J. Connelly, Mgr., will receive bids until January 12 for generator and switchboard.

Pumps—Shelby, O.—City plans to purchase two 1 m.g.p.d. centrifugal pumps for proposed sewage disposal plant. Estimated cost $150,000.

Motors—Annapolis, Md.—Bureau of Supplies & Accounts, Navy Dept., Washington, D. C., will receive bids until January 5 for 10 d.c. electric motors. Sched 7145.

Motors, Generators, Sets—Brooklyn, N. Y. and Portsmouth, N. H.—Bureau of Supplies & Accounts, Navy Dept., Washington, D. C., will receive bids until January 5, for one motor for main engine lubricating pump for Navy Yard, Brooklyn, and two motor generator sets at Portsmouth.

Pumps and Motors—Cairo, Egypt—Ministry of Interior, Cairo, will receive bids until February 18, for supply and delivery of pumps and electric motors for Samalbout waterworks.

Industrial Projects

Ia., Council—Iowa Products Co., plans reconstruction of soda plant destroyed by fire. Estimated cost $150,000.

Mass., Canton—Draper Bros. Co., Draper Lane, will not construct power house. $40,000. Project postponed indefinitely.

Me., Biddeford—Saco-Lowell Shops, manufacturers of textile machinery, plans to consolidate plant at Newton Upper Falls, Mass., with Biddeford plant alterations and extensions. Estimated cost to exceed $40,000.

N. Y., Lackawanna—Spring Perch Co., Stratford, Conn., awarded contract for construction two factory buildings, each 2 story, 165 x 250 and 60 x 200 ft. for the manufacture of automobile springs at Hamburg Turnpike to Buffalo Tank Corp., 123 Lincoln Ave., Lackawanna, N. Y. $150,000.

O., Cleveland—William A. Howe Co., E. W. Reutner, Pres. and Treas., 2630 Payne Ave., manufacturers of mountings for lithographs, plans construction of a 2 story factory on East 27th St. Estimated cost $50,000. Architect not announced.